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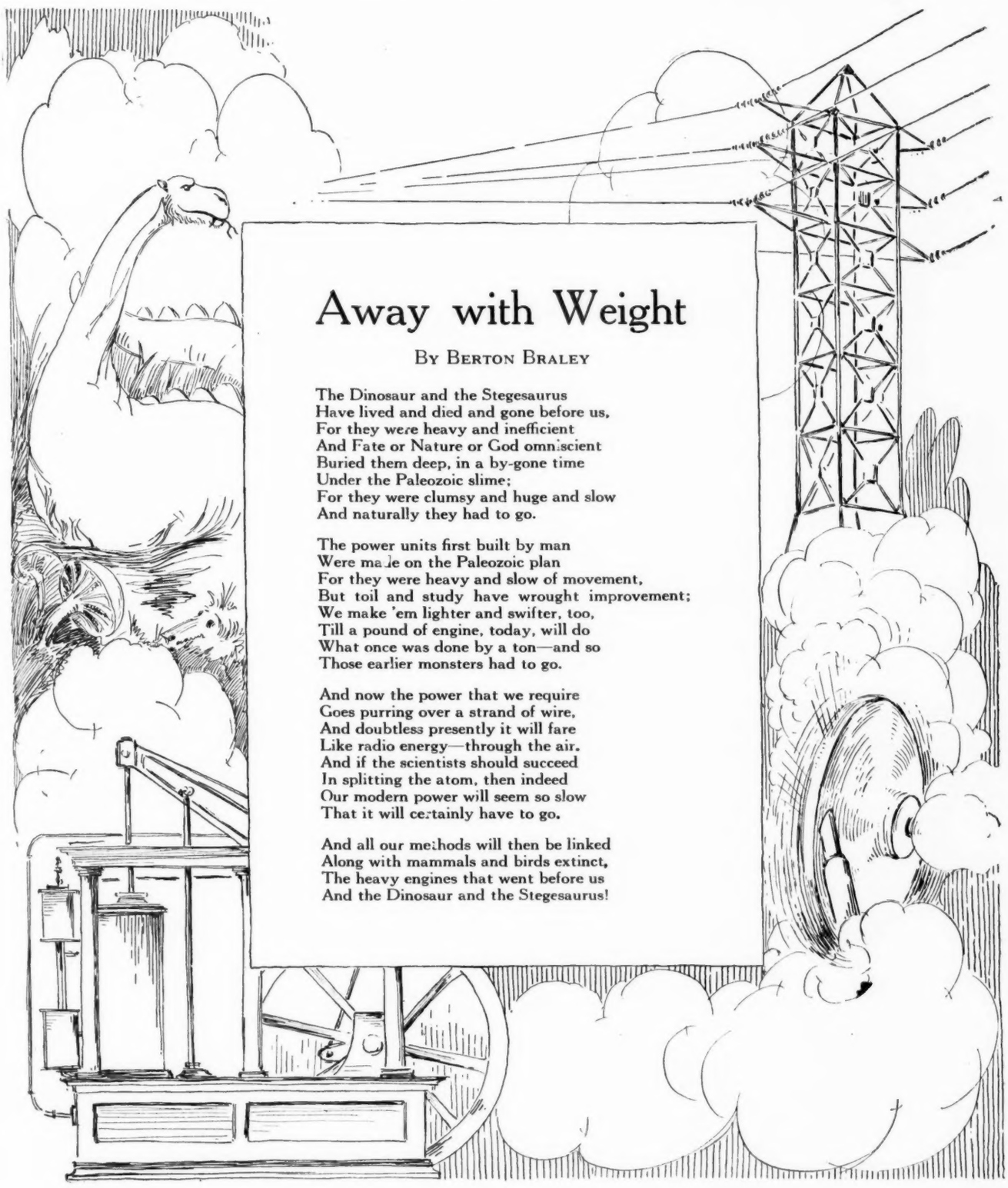


Away with Weight

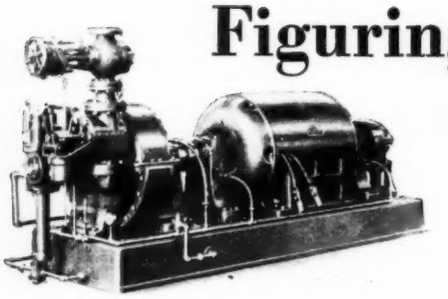
By Berton Braley

The Dinosaur and the Stegesaurus
Have lived and died and gone before us,
For they were heavy and inefficient
And Fate or Nature or God omniscient
Buried them deep, in a by-gone time
Under the Paleozoic slime;
For they were clumsy and huge and slow
And naturally they had to go.

The power units first built by man
Were made on the Paleozoic plan
For they were heavy and slow of movement,
But toil and study have wrought improvement;
We make 'em lighter and swifter, too,
Till a pound of engine, today, will do
What once was done by a ton—and so
Those earlier monsters had to go.

And now the power that we require
Goes purring over a strand of wire,
And doubtless presently it will fare
Like radio energy—through the air.
And if the scientists should succeed
In splitting the atom, then indeed
Our modern power will seem so slow
That it will certainly have to go.

And all our methods will then be linked
Along with mammals and birds extinct,
The heavy engines that went before us
And the Dinosaur and the Stegesaurus!



Figuring Steam Requirements for Combined Bleeder-Mixed-Pressure Turbine

By J. Y. DAHLSTRAND
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AN INDUSTRIAL plant may be efficiently served by a combined turbine automatically adjusting itself to the variations of load as well as to an excess or deficiency of process steam. Convenient methods for determining steam consumption under any given condition are here illustrated.

INDUSTRIAL plants frequently must distribute low-pressure steam for such uses as heating, cooking, drying, etc. The demand for such low-pressure steam may vary rapidly or slowly, or in unusual cases it may be of constant amount. Sometimes, prime movers such as pumps, engines, auxiliary-drive turbines, etc., are arranged to exhaust into low-pressure systems, so that they may supply exactly the required amount of steam. Conditions may arise, however, in which they would supply more than the required amount or less than the required amount.

A low-pressure system which sometimes requires steam and at other times has a surplus of steam to be ordinarily wasted, may be served by a combined bleeder-mixed-pressure type of turbine.

If it is not necessary to carry a definite constant load and if the turbine can be regulated to take just as much load as will give the required exhaust steam, and also the exhaust steam system be so constructed and designed that no surplus is ever on hand, the most efficient plant arrangement is met with. This would require a non-condensing turbine with a back-pressure regulator. In this case all the exhaust steam is utilized in process work, and as the demand slacks the load is reduced accordingly by the regulator and no steam wasted.

The combined type of turbine is illustrated in Fig. 1 and in the headpiece. Steam entering by the throttle valve *A*, Fig. 1, is passed through the first stage, which is a multi-velocity stage, and enters the space *B*. This space is piped to the low-pressure steam system. Flat valves, such as marked at *C*, are operated by the governor to admit steam also from space *B*, through the remaining stages of the turbine as required. The description of the valve gear and its mechanical action would be too extensive for present consideration. Such a valve gear was described in detail in the July 3, 1923, issue.

In describing the five different functions in which such a turbine automatically operates, it is assumed that the load curve must be followed by this unit so that it is not possible to vary the load from the actual demand in order to suit steam conditions.

As a high-pressure condensing unit a definite amount of station load must be carried without any demand by the low-pressure steam system. This means that there is neither a surplus nor a deficiency of low steam, and that all steam admitted to the high-pressure stage of the turbine, Fig. 1, is allowed to pass through the low-pressure stages to the condenser.

As a bleeder turbine the low-pressure system must require a certain amount of steam. Ordinarily, the pressure falls slightly and by means of the automatic pressure governor closing valves *C*, steam from the bleeder space at *B* is admitted to bring the low-pressure system to normal steam pressure. In this instance low-pressure process steam is required, but it may be considerably less than all that is available as exhaust steam from the high-pressure turbine alone.

Condition of Greatest Efficiency

If the low-pressure steam demand now increases, more steam will be taken from the space *B* and a point will be finally reached where all the steam passing through the first wheel is bypassed to the low-pressure system, with none going to the condenser. Under these conditions the unit would operate as a straight non-condensing turbine, representing the most efficient point of plant operation, since the entire amount of exhaust steam is utilized and none wasted as heat in the condensing circulating water.

For operation as a mixed-pressure unit conditions in the low-pressure steam system must be such that there is a surplus of low-pressure steam to be utilized. In such a case the pressure would rise in the low-pressure system and steam would then be admitted automatically to the space *B* and by means of the flat valves *C* into the low-pressure part of the unit. This would represent mixed-pressure operation since both high-pressure steam and low-pressure steam are furnished for carrying load. In this instance the station load must be more than the supply of low pressure steam will carry.

A fifth condition, that of the low-pressure turbine, will result from a still greater surplus in the low-pressure-steam system. If this surplus increases, a point will finally be reached where steam bypassed from the low-pressure system through the low-pressure stages of the turbine will carry all the load. This will represent low-pressure, condensing operation, and requires that the load shall be exactly at the point where the surplus of low-pressure steam will carry it. No high-pressure steam is therefore admitted.

If the load is further reduced, an undesirable sixth condition will exist. Then there will be less load than the surplus low steam can carry. The governor will then throttle down on the low-pressure steam admission and the pressure in the low-pressure system will rise until the blowoff valve relieves it, thus wasting steam. This last condition will not ensue if there is a means of increasing the load carried, such as might happen by cutting down the load on other units if in multiple.

The usual method of representing the steam requirements in accordance with various load conditions of a bleeder turbine is indicated in Fig. 4. Before taking up the method of using this diagram, however, it is preferable to review the means by which it is derived.

In Fig. 2 there is plotted the so-called Willans line for the high-pressure element of a 1,000-kw. bleeder-type turbine. This shows the amount of steam required per hour for any load and is sufficiently correct for practical purposes when using a single throttling governor. The various steam consumptions for the loads would fall sufficiently close to a straight line so that this represents, practically speaking, the actual relation. At no-load it will be noted that about 2,000 lb. of steam is required per hour to operate the machine.

High- and Low-Pressure Willans Lines Combined to Show High-Pressure Condensing Type

The solid line in Fig. 3 shows a similar Willans line for the low-pressure element of the steam turbine. This is plotted opposite to that as shown in Fig. 2. In other words, the zero point of the bottom scale is at

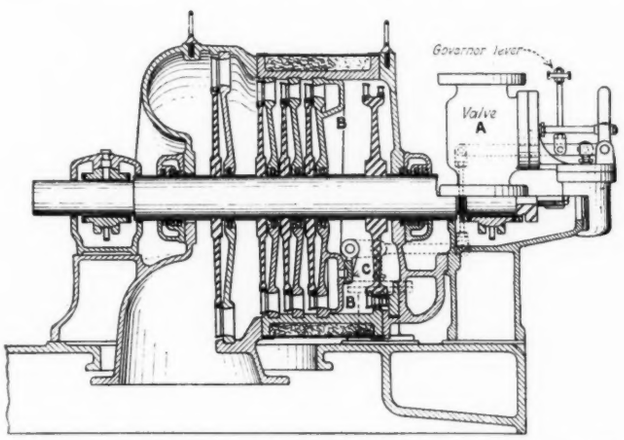


Fig. 1—Turbine that may operate automatically in five different capacities as described

the right of the figure for the solid line representing the low-pressure element.

Assume that the two curves are drawn on tracing paper, which is transparent, and are now laid upon each other. The line for the high-pressure element is shown as dotted. The zero point of the bottom scale for the high-pressure line is placed over the 1,000-kw. point for the low-pressure element.

These two lines intersect each other at 16,400 lb. of steam per hour represented on the scale at the left. This means that 16,400 lb. of steam supplied to the high-pressure turbine will develop 495 kw. shown on the bottom scale, and if the same amount of steam is passed into the low-pressure turbine it will develop 505 kw., as indicated on its scale. As a straight high-pressure condensing turbine, therefore, 1,000 kw. of energy altogether will be developed on 16,400 lb. of steam.

Low-Pressure Line Raised to Show Bleeder Type

Now suppose it was desired to keep the load at 1,000 kw. but to bleed 10,000 lb. of steam per hour. It will then be necessary to increase the load on the high-pressure element and decrease the load on the low-pressure element. The low-pressure turbine will then take less steam and the high-pressure will be supplied more, so that the difference between the two quantities will be discharged into the low-pressure system after passing through the high-pressure part of the turbine.

This condition will be represented on the diagram by raising the low-pressure Willans line a distance of 10,000 lb. as indicated on the scale at the right. The intersection will now show the high-pressure element generating 660 kw. as indicated on the bottom scale and taking 21,200 lb. of steam per hour. The low-pressure element generates 340 kw. and takes 11,200 lb. per hour. The difference between these two is 10,000 lb. per hour discharged or bled.

High-Pressure Line Raised for Mixed-Pressure Type

When operating as a mixed-pressure turbine, with 1,000 kw. load, the high-pressure element will take less steam than if it were running straight-high-pressure-condensing. The low-pressure element will receive steam that is passed through the high-pressure turbine

TABLE OF TURBINE STEAM CONSUMPTIONS AS REQUIRED TO PLOT FIG. 5

Straight High-Pressure Condensing

Load in Kw.	Steam in Lb. per Hr.
0	1,750
100	3,300
200	4,850
250	5,650
300	6,450
400	8,000
500	9,500

High-Pressure Non-Condensing

Willans line of high-pressure element

Load in Kw.	Steam in Lb. per Hr.
100	3,410
500	18,750

Bleeder Operation

Load in Kw.	Steam Bled Lb. per Hr.	Steam Supplied Lb. per Hr.
500	15,000	16,900
500	12,500	15,700
500	10,000	14,450
500	7,500	13,250
500	5,000	12,000
500	2,500	10,525
385	15,000	(800 lb. exhausted from hp)
420	15,000	(500 lb. to condenser)
250	10,000	10,510
250	7,500	9,400
250	5,000	8,150
250	2,500	4,450
225	10,000	(800 lb. exhausted from hp)
248	10,000	(500 lb. to condenser)

Mixed-Pressure Operation

Load in Kw.	Low-Pressure Steam Supplied Lb. per Hr.	High- and Low-Pressure Steam Supplied, Lb. per Hr.
500	12,500	14,200
500	10,000	13,300
500	7,500	12,300
500	5,000	11,400
500	2,500	10,500
300	10,000	10,200
300	7,500	9,250
300	5,000	8,300
300	2,500	7,490

and also an additional amount of low-pressure steam received from the low-pressure system.

Suppose that 20,500 lb. of steam were received per hour from the low-pressure system and passed through the low-pressure turbine, while 1,000 kw. of load were being carried. This condition can be indicated on Fig. 3 by raising the high-pressure line an amount equal to 20,500 lb. as indicated at the left of figure. It will be seen that the low-pressure steam consumption is thereby increased by 20,500 lb. of steam. The high-pressure element will then carry 140 kw. at 6,200 lb. of steam while the low-pressure turbine will deliver 860 kw. at 26,700 lb. of steam. The total steam received by the low-pressure element is 26,700 lb., consisting of 6,200 from the high-pressure element and 20,500 from the low-pressure system.

The steam consumption, when 1,000 kw. or any other load is carried on the low-pressure turbine alone, is indicated by the low-pressure Willans line (1,000 kw. at the upper left-hand corner). If the high-pressure

turbine carries a load alone, this steam consumption is illustrated by the corresponding point of the high-pressure Willans line. The diagram therefore shows steam consumption at any load with the turbine operating either as a straight-high-pressure condensing machine, a bleeder, a mixed-pressure, a high-pressure non-condensing, and a low-pressure condensing turbine. Five different capacities are represented. The bleeder, mixed-pressure and straight-condensing, however, are shown only for a load of 1,000 kilowatts.

Lines Closed Together for Lighter Load

The same type of diagram can be used for a lighter load, such as 500 kw., by laying the lines on top of each other so that the zero point on one horizontal scale corresponds with the 500 point on the other horizontal scale. Performances for 500 kw. may be then worked out in the same manner, for the three combined functions as just mentioned. The conventional diagram can therefore be drawn for any load and showing any one of the five operating conditions.

The performance of this unit as a bleeder turbine only is given in the usual conventional manner in Fig. 4. The total load carried is plotted horizontally and the total steam supplied the unit per hour plotted vertically. It is possible to tell the entire steam required for the unit at any load and at any amount of bled steam.

Example: With a total load of 400 kw., bleeding steam at 2,500 lb. per hour, find the total steam required, and steam consumption per kilowatt-hour. By following the vertical line dotted on the 400-kw. load, extended to the line for 2,500 lb. bled steam, it will be found that the total steam consumption for the turbine is 8,670 lb. per hour, making the consumption per kilowatt-hour 21.65 pounds.

Fig. 4 can be constructed from Fig. 3. The bleeding point for 10,000 lb. per hour is plotted on Fig. 4 in the same way as Fig. 3. If diagrams are constructed at lower loads, a number of points will reveal that the line for 10,000 lb. bleeding steam will run in a straight line diagonally downward. This will terminate at the line of high-pressure operation, where there is no steam being passed to the low-pressure unit whatever.

It will also be noted, from Fig. 4, that when bleeding 10,000 lb. of steam at a load of 240 kw. no steam is bypassed to the low-pressure elements. The turbine operates from the high-pressure end entirely.

The performance of this unit as a mixed-pressure turbine may be plotted in the same manner as Fig. 4. The oblique lines would then represent pounds of low-pressure steam admitted from the main system instead of that bled. These would be limited by the line representing operation as a low-pressure turbine entirely.

High-Pressure Nozzle Capacity Increased to Carry Full Load

The Willans line representing the original high-pressure part of the turbine will be modified somewhat on account of changes required in adjusting the turbine for bleeder-mixed-pressure operation. In the latter case the nozzles of the high-pressure element must be increased so as to carry 1,000 kw., the full generator load, when non-condensing. This is equal to both low- and high-pressure capacities when acting together, as originally.

A slightly higher water rate at 500 kw. will result on account of throttling therefore necessary. Also, in the latter condition all rotational losses are carried by this element. The changed or readjusted Willans line is therefore indicated in Fig. 4.

There is a third Willans line at the extreme left of Fig. 4, showing straight non-condensing performance for the unit. The readjusted line is here raised a definite amount, so as to allow some steam being passed through the low-pressure turbine for cooling the interior, which would heat up on account of rotational losses. The condenser is assumed as bypassed.

The load on a turbine of this kind may change so as to operate it in four or five different capacities at frequent intervals during the day. Determining the steam required for several sets of conditions can

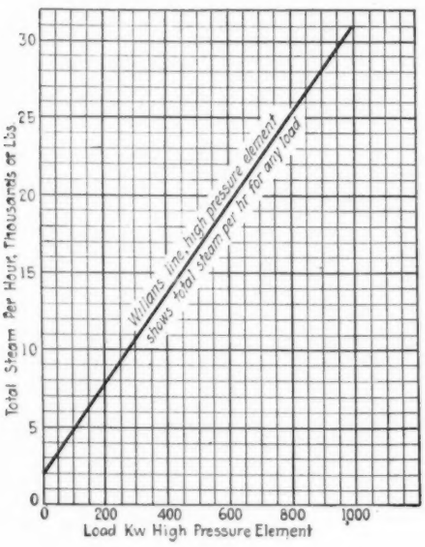

Total Steam Per Hour, Thousands of Lbs.
Willans line, high pressure element shows total steam per hr for any load
Load Kw High Pressure Element

Fig. 2—Willans line for high-pressure element shows steam required per hour at any load

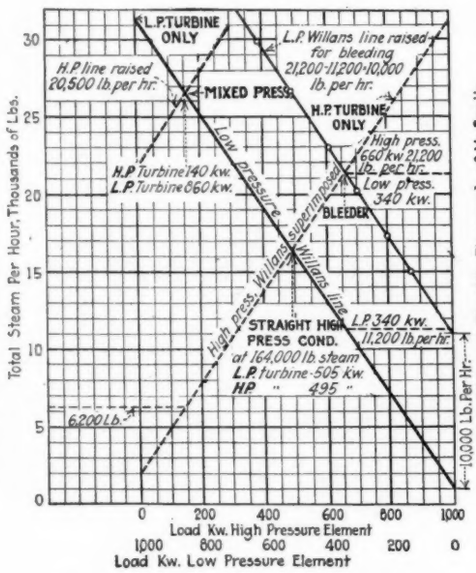

L.P. TURBINE ONLY
L.P. Willans line raised for bleeding 21,200-11,200-10,000 lb. per hr.
H.P. line raised 20,500 lb. per hr.
MIXED PRESS.
H.P. TURBINE ONLY
High press. 660 kw 21,200 lb. per hr.
Low press. 340 kw.
H.P. Turbine 140 kw.
L.P. Turbine 660 kw.
BLEEDER
Low pressure Willans line superimposed
High press. Willans line
STRAIGHT HIGH PRESS COND.
at 164,000 lb. steam
L.P. turbine 505 kw.
HP " 495 "
L.P. 340 kw. 11,200 lb. per hr.
6,200 Lb.
10,000 Lb. Per Hr.
Total Steam Per Hour, Thousands of Lbs.
Load Kw. High Pressure Element
Load Kw. Low Pressure Element

Fig. 3—Willans lines for high- and low-pressure elements combined to show steam conditions for each type

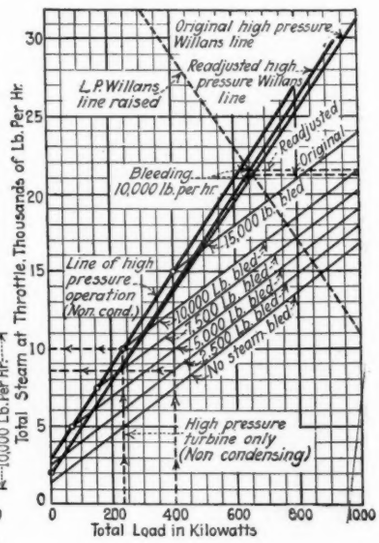

Original high pressure Willans line
Readjusted high pressure Willans line
L.P. Willans line raised
Bleeding 10,000 lb. per hr.
Readjusted
Original
15,000 Lb. bled
10,000 Lb. bled
7,500 Lb. bled
5,000 Lb. bled
2,500 Lb. bled
No steam bled
Line of high pressure operation (Non cond.)
High pressure turbine only (Non condensing)
Total Steam at Throttle, Thousands of Lb. Per Hr.
Total Load in Kilowatts

Fig. 4—Usual diagram for bleeder operation by methods illustrated in Fig. 3

be simplified with a combined chart as Fig. 5 for a 500-kw. turbine. Suppose for instance, that with a load of 145 kw., bleeding 5,000 lb. of steam per hour, the water rate must be found. This can be read from the chart directly as indicated by the dotted line, beginning from the right at 145 kw. This is 6,500 per hour or 44.8 lb. per kw.-hr.

Suppose that no steam were taken from the turbine owing to another change in the industrial plant so that pure condensing operation were necessary with a load of 160 kw. It can be found, as shown by dotted lines from 160 kw. at the right, that 4,200 lb. would be required per hour, giving a water rate of 26.25 per kilowatt.

Similarly, as a mixed-pressure turbine, if the load

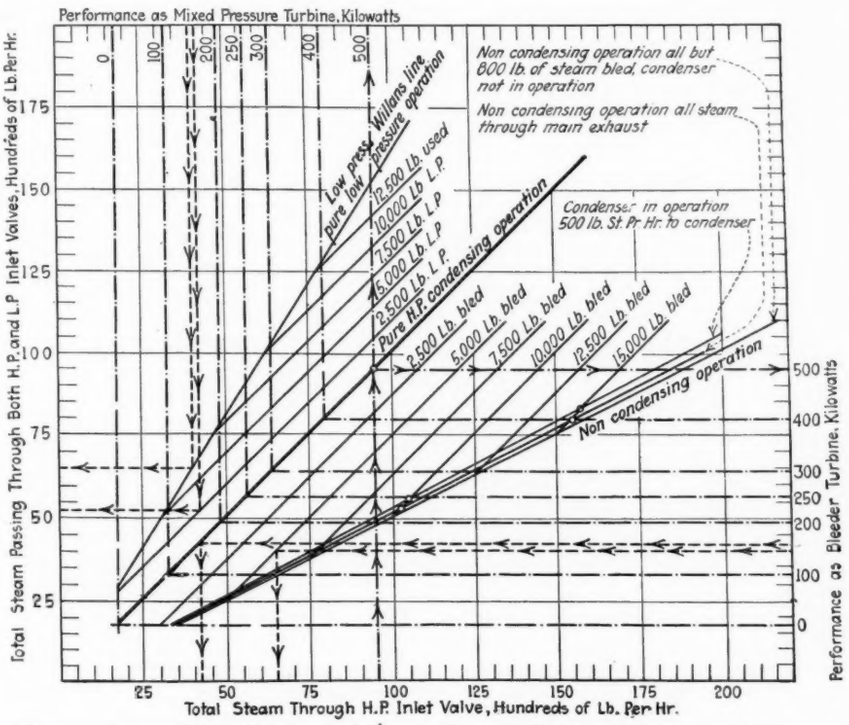

Performance as Mixed Pressure Turbine, Kilowatts
Total Steam Passing Through Both H.P. and L.P. Inlet Valves, Hundreds of Lb. Per Hr.
Total Steam Through H.P. Inlet Valve, Hundreds of Lb. Per Hr.
Performance as Bleeder Turbine, Kilowatts
Non condensing operation all but 800 lb. of steam bled, condenser not in operation
Non condensing operation all steam through main exhaust
Condenser in operation 500 lb. St. Pr. Hr. to condenser
Willans line
Low press. pure low pressure operation
12,500 Lb. used
10,000 Lb. L.P.
7,500 Lb. L.P.
5,000 Lb. L.P.
2,500 Lb. L.P.
Pure H.P. condensing operation
2,500 Lb. bled
5,000 Lb. bled
7,500 Lb. bled
10,000 Lb. bled
12,500 Lb. bled
15,000 Lb. bled
Non condensing operation

Fig. 5—Convenient diagram shows steam conditions when operating as a high-pressure condensing, low-pressure condensing, high-pressure non-condensing, bleeder or a mixed-pressure turbine

were 160 kw. with 2,500 lb. received from the low-pressure system and admitted to the low-pressure turbine, it will be found that a total of 5,200 lb. will be received into the turbine representing 5,200 — 2,500 = 2,700 lb. of high-pressure steam required to carry the load per hour. Suppose that 145 kw. will be reached, giving that of pure low-pressure operation. The total steam is indicated at 6,500 lb. per hour, and the water rate 44.8 lb. per kw.-hr.

It will be noticed that lines close to the non-condensing point are also drawn representing definite values of steam admitted to the condenser, and also with the condenser valve shut.

The first step in constructing a chart as Fig. 5 is to determine roughly the total amount of steam as represented in the horizontal and vertical scales that would apply to a machine of this size. These amounts are laid off in a convenient manner, horizontally and vertically.

The line representing high-pressure-condensing operation is drawn at an angle of 45 deg. slanting upward to the right.

The next step is to locate the kilowatt scale representing the load at the right and at the upper horizontal margin. The steam required in pounds per hour for the unit in straight-high-pressure condensing operation is first calculated as in the table. This may be checked off from the combined corrected Willans line. Two points, at a considerable distance apart, may be located from which the Willans line for the entire unit can be drawn. The steam consumption at loads of 100, 200 kw., etc., as shown in the table, can then be easily found.

The 500-kw. load point at the right can be found by extending vertically 9,500 lb. of steam to the pure high-condensing line, and then extending horizontally to the bleeder scale and marking it 500. In a similar way the 500 point for mixed-pressure operation can be obtained. The other load points can be checked off in the same manner and located by heavy dot-and-dash lines.

The line representing non-condensing operation, which is also the Willans line for the high-pressure unit, can be laid off from the load scale and the steam inlet scale below, from two values given in the table. In the same way the low-pressure condensing line at the extreme left, which represents the low-pressure turbine Willans line, can then be located.

The line for bleeder operation can then readily be filled in from the fact that these straight lines are also parallel. The relation of steam supplied for 500-kw. load at various bleeder amounts can be worked out as shown in the table. Thus one point in each line can be located. By taking similar results for a load of 250 lb., a second point in each line can be located so that these lines may be readily drawn in. The two short lines at the left only necessarily require one point of location to which they can be drawn parallel with sufficient accuracy ordinarily.

It is desired in addition to draw two lines, one of which indicates operation with all but 800 lb. of steam bled and the other operation when 500 lb. of steam is admitted to the condenser. These lines are located by means of two points each, as indicated by circles in the figure.

By means of the two Willans lines, the load when 1,500 lb. of steam is bled, and 800 lb. passed through the low-pressure turbine, can be obtained. In this case the condenser is shut down and the remaining steam is passed through but not doing any work practically speaking. The load then can be calculated entirely from the high-pressure Willans line.

In the lines where 800 and 500 lb. goes to the condenser, the work supplied by the low-pressure turbine must be taken into consideration. The load that would occur under these two conditions can then be located as shown in the table.

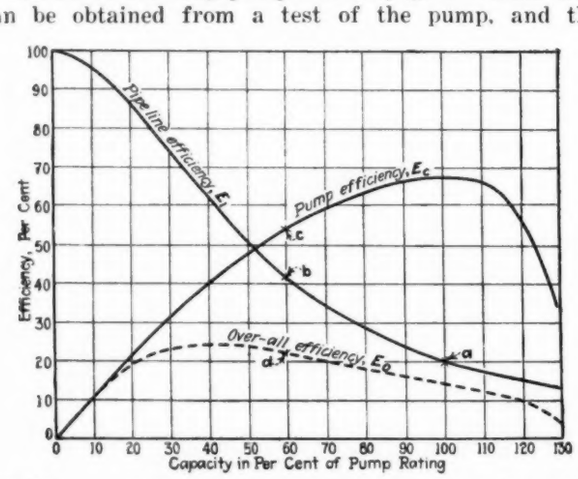
The mixed-pressure part of the diagram can readily be inserted by figuring values for two different loads, as also in the table. The slanting line to the right representing different amounts of steam supplied to the low-pressure element can then be drawn in from points located on the diagram.

Planning Centrifugal Pumping Installations for Maximum Efficiency

By Russell K. Annis

IN PLANNING a centrifugal pumping installation the question of the efficiency of the pump is obviously important and yet it is always of less importance than the efficiency of the installation as a whole. For this reason the accompanying illustration, which shows the effect that pipe-line friction has on over-all efficiency, has been prepared. It also offers a method of selecting a pump so adapted to the line that the best result will be obtained. It is commonly believed that the lower the capacity the better will be the efficiency because of reduced friction, but the curve of over-all efficiency shows that this is not the case.

The curve showing pump efficiency gives values that can be obtained from a test of the pump, and the


Pipe line efficiency, E_l
Pump efficiency, E_c
Over-all efficiency, E_o
a
b
c
d
Efficiency, Per Cent
Capacity in Per Cent of Pump Rating
0 10 20 30 40 50 60 70 80 90 100 110 120 130
0 10 20 30 40 50 60 70 80 90 100

Plotting over-all efficiency shows best pumping point is at 45 per cent of pump rating

ordinates in this case have been arranged in terms of per cent of pump rating. The point of maximum efficiency is plotted at 100 per cent capacity.

The curve showing pipe-line efficiency and also the curve of over-all efficiency, were computed as follows. Let

Q = Pump capacity, expressed in per cent of pump rating;
H_s = Static or useful head in feet (assume 25 ft.);
H_f = Friction head in feet (assume $H_f = K(0.01Q)^2$;
E_l = Pipe-line efficiency, per cent;
E_c = Centrifugal pump efficiency, per cent;
E_o = Over-all efficiency, per cent;
K = Friction head in feet at 100 per cent pump capacity.

Then $$E_l = \frac{H_s}{H_s + H_f} = \frac{25}{25 + K(0.01Q)^2}$$

and $$E_o = (E_l \times E_c) \div 100$$

The numerical values assumed in the foregoing equations are based on a pump rated at 500 gal. per min. pumping through 600 ft. of 4-in. discharge line, with a vertical rise of 25 ft. It is of course an extreme case of low static head, and yet such cases are not entirely unknown. This low value for static head is used in order to bring out more clearly the effect of pipe-line efficiency.

Example: For 500 gal. per min. the friction as given by a friction table is 7.43 lb. per 100 ft. of pipe, or $7.43 \times 2.31 \times 6 = 103$ ft. for 600 ft. of pipe. The actual useful head is the static head of 25 ft. The head against which the pump has to work is $103 + 25 = 128$ ft. Therefore the efficiency of the pipe line is $(25 \div 128) \times 100 = 19.5$ per cent.

This value is plotted on the curve at *a*, and other points are found by taking, say, 60 per cent of 500 and getting the efficiency in the same way.

The friction can also be calculated from the formula, $H_f = K(0.01Q)^2$, K being the friction in feet at 100 per cent capacity which in the present example is 103. The capacity in per cent is represented by Q. At 60 per cent capacity the pipe-line friction is $H_f = 103 \times (0.01 \times 60)^2 = 37$; the total head, 62; and the pipe-line efficiency is 40.3 per cent. This point is plotted on the curve at *b*.

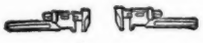
Now the pump efficiency is taken from a test. At 60 per cent capacity it is seen to be 54 per cent as shown at *c*. The over-all efficiency is the product of the pipe-line efficiency and the pump efficiency, divided by 100, or $(40.3 \times 54) \div 100 = 21.8$ per cent. This point is plotted at *d*.

The curves resulting from these calculations show distinctly that it would be uneconomical to operate this outfit at 100 per cent rating, because the efficiency is only 14 at that capacity. The maximum over-all efficiency occurs at 45 per cent rating, which would be, in the case assumed, 225 gal. per min.

It should be emphasized that the pump should not be throttled to this point, as this would defeat the fundamental object of the scheme, which is to save by reducing friction. The throttling would not only reduce the efficiency of the pump, but it would also increase the total friction head. The reduction in capacity must be accomplished either by reducing the speed, by reducing the diameter of the impeller, or by using a smaller size of pump.

It may be that the demand for water is actually 100 per cent or more, and in that case it would be impossible to effect any economy by this method. However a diagram of this type might show that a larger pump or a larger size of pipe is required.

The important thing to remember is that there is one capacity that is more economical than any other, and the installation should be planned so as to operate as near as possible to that point. It is a good plan to use a variable-speed motor and operate at the economical point as much as possible, increasing the speed only when excessive demands are made.



A process of chromium plating producing wearing surfaces harder than any other known metal, with a finish having twenty times the life of nickel plate, has been perfected by Dr. Colin G. Fink, head of the division of electrochemistry at Columbia University, it is announced in the press. Next to the diamond, the new plating will be the hardest substance in existence. Dr. Fink says. Chromium has been used hitherto only as an addition to steel to produce an extremely hard alloy. The price of chromium varies from 60c. to $1 a pound. Dr. Fink says the new surface can be produced at a cost not much exceeding that of nickel plate. It will not rust or tarnish.

Synchronous Motors Used for Voltage and Power-Factor Regulation

By S. H. MORTENSEN
Electrical engineer, Allis-Chalmers Manufacturing Company.

SOME of the problems that have accompanied the recent expansions of power systems have been solved with the aid of synchronous motors operating as phase modifiers. A synchronous motor floating on a power system and operated with either over- or under-excited fields draws a wattless current and acts as a phase modifier. When the field poles are over-excited, the machine draws a leading wattless current and acts as a synchronous condenser. When the field poles are underexcited, the motor draws a lagging wattless current and acts as a synchronous reactor. Between these two limits are the applications where part of

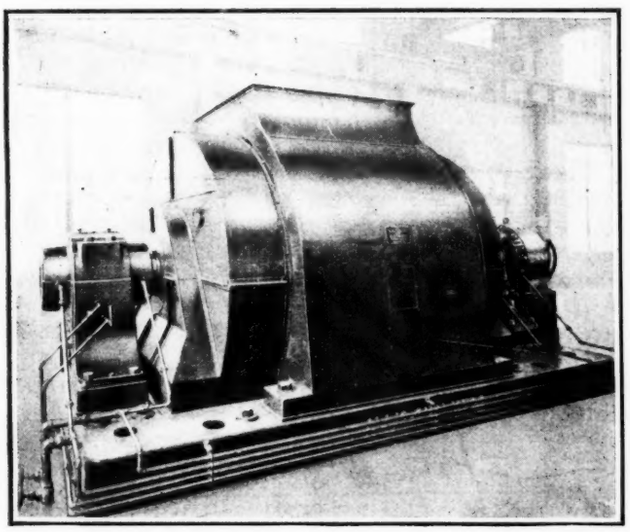


Fig. 1—Three-phase 720-r.p.m. 15,000-kva. phase modifier

the motor capacity is utilized for the development of mechanical power and the remainder for power-factor correction.

These characteristics make the synchronous motor a suitable medium not only for controlling the power factor of a power system, but also for regulating its voltage, as the latter depends upon the load transmitted, its power factor and upon the transmission-line constants. For a given sending voltage and kilowatt load the receiving voltage at different points of the system depends mainly upon the magnitude of the wattless component of the load, since the electromotive force corresponding to the line self-induction adds algebraic to the sending voltage for leading current and subtracts from the sending voltage for lagging current. The voltage drop due to the ohmic resistance of the line is for lagging and leading currents in quadrature with the receiving voltage and of correspondingly small influence upon the voltage regulation. For unity-power-factor operation, the resistance drop is in phase with the receiving voltage and subtracts directly, whereas the voltage due to line self-induction is in quadrature and of correspondingly small influence. In short, by modifying the power factor of the current transmitted, the direction of the ohmic and self-induced electromotive forces with respect to the sending voltage may be exerted in such a direction as to insure any desired voltage condition at the receiving end of the line.

Maintaining Distributing Voltage Constant

The importance of maintaining the distributing voltage constant or nearly constant is well understood and has for small blocks of power been accomplished successfully with the aid of induction regulators. In installations where large blocks of power are transmitted over short distances, the voltage at the receiving end can, within limits, be regulated by varying the voltage in the generating station. Where large blocks of power are transmitted over long distances, the methods cited are too limited and other means must be provided. Where voltage adjustment alone is involved, transformers with taps and tap-changing devices may be sufficient, but where voltage and power-factor regulation are involved, phase modifiers are generally resorted to.

By adjusting the exciter-voltage of the modifier with an automatic voltage regulator, its excitation and load of lagging or leading current can be regulated to meet varying load conditions. Voltage regulators of the standard vibrating type can be used in installations where leading current alone is involved, but where reactor as well as condenser operation is required, broad-range regulators generally are required. Under extreme conditions such as may prevail when a line is being charged or during periods of light loads, the modifier is called upon to carry its maximum reactor load, which requires low field excitation. If the corresponding exciter voltage is less than its residual, it becomes necessary to insert resistance in the modifier field circuit, which may be done by means of relays operating in conjunction with the main voltage regulator.

The wide range of field excitation corresponding to loads varying between rated kva. lagging and leading may be seen from the "V" curve *A* in Fig. 2, and saturation curves in Fig. 3, which are plotted from tests obtained on a 6,600-volt modifier with a maximum condenser rating of 15,000 kva. and a maximum reactor rating of 10,000 kva. For condenser operation the machines excitation varies between the 91 amperes corresponding to no load, normal voltage, and 233 amperes corresponding to the rated leading kva. at 7,050 volts. For lagging current the excitation varies between 91 amperes for no load and the 19 amperes required for the full reactive rating of 10,000 kva. at about 6,500 volts.

The voltage impressed at the terminals of a phase modifier which is operated from the tertiary or secondary windings of transformers whose primary voltage is maintained constant will vary with its load and power factor. This is due to the influence of the electromotive force of the self-induction of the transformer, which for leading current increases and for lagging current decreases the terminal voltage of the condenser. This is brought out in Fig. 2, curve *B*,

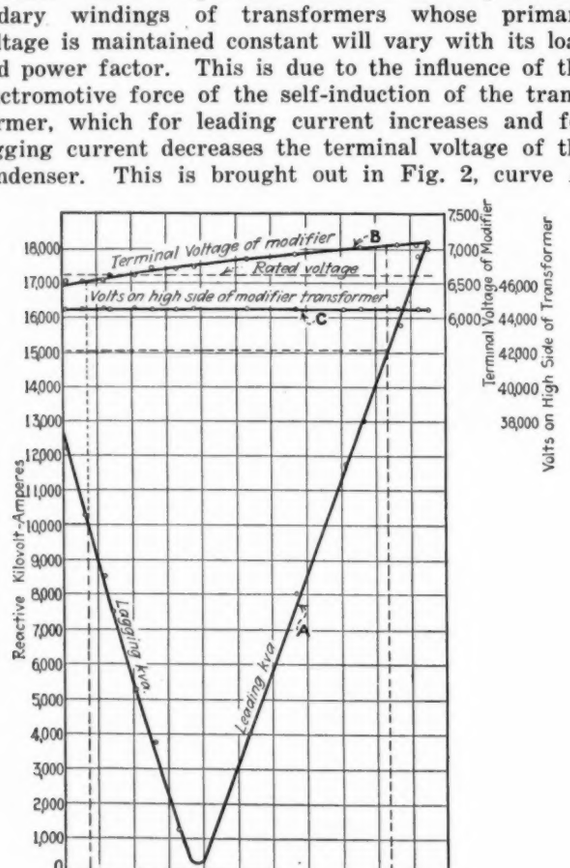


Fig. 2—Shows how load varies on phase modifier with changes in field current

which is based on tests on a 15,000-kva. modifier operated from the tertiary winding of a bank of transformers whose receiving voltage shown by curve *C*, was maintained constant. Curve *B* shows that the terminal voltage of the modifier varies from 7,050 volts for 15,000 kva. leading to about 6,500 volts for 10,000 kva. lagging load. This condition limits the percentage of reactance permissible in the transformer windings and should also be considered when the capacity and voltage ratings of the condenser are determined.

The importance of transformer reactance is shown by Fig. 3, which is the no-load and full-load field saturation curves for lagging and leading power factors of the 15,000-kva. modifier. With a load of 15,000 kva. leading the field excitation required with a terminal voltage of 7,050 volts is 233 amperes or 10 per cent higher than the excitation required when this load is carried at the rated voltage of 6,600 volts. This increase is due to the increased iron saturation inherent to the higher operating voltage. For a reactive load of 10,000 kva. the self-induction of the transformers reduces the modifier terminal voltage to about 6,500, and under these conditions its reactive capacity is 3 per cent less than it would be at the rated voltage of 6,600. In short, from the point of view of modifier design it is desirable to keep the transformer reactance as low as is compatible with safe design.

The problem of power-factor improvement encountered in many industrial installations should not be confused with that of voltage regulation. Whereas the latter may require both under- and over-excited motor operation, the former can be solved with either synchronous or static condensers. This type of equipment, however, should not be installed until all other means of power-factor improvement have been applied. These means include the replacing oversize induction motors with machines of the proper size or, if practicable, with unity-power-factor or over-excited synchronous motors. In some installations it may also be practicable to replace a number of small transformers and motors with one large one. By this and similar means improvements can be effected. Many installations which previously were considered suitable for induction-motor drives only, can now be handled successfully with a self-starting synchronous motor designed to develop the required starting, pull-in and pull-out torques.

The factors that determine the electrical design of a phase modifier are the heating of the stator and rotor windings and the requirement that its operating losses must be as low as possible relative to the output. As

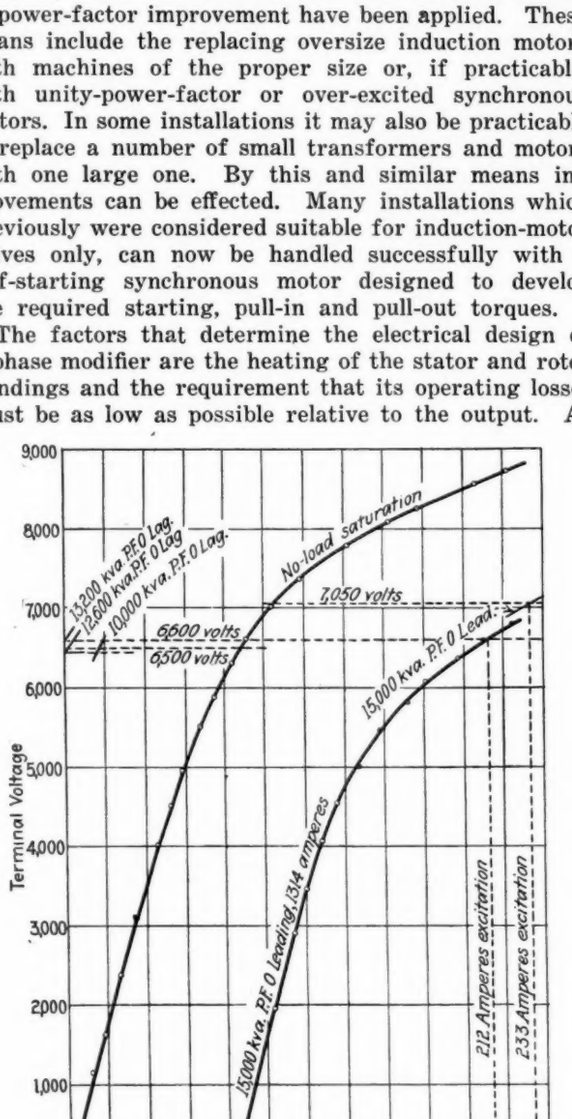


Fig. 3—Relation between terminal voltage, field excitation and capacity of phase modifier

it does not carry any mechanical load, its pull-out torque can be reduced to a value sufficient to keep it in step under voltage fluctuations. This permits the machine to be designed with high armature reaction. The length of the air gap depends upon the reactive-kva. rating of the machine. If it is to operate as a condenser only, its gap can be made as short as the pole-face and damper-winding losses inherent to the use of open stator slots will permit. A machine designed along these lines will carry from 35 to 45 per cent of its kva. rating as a reactor. If designed for lagging current operation only, the air gap must

be long, as the kva. the reactor will draw from the line for a given terminal voltage depends upon the length of the air gap, as well as upon the armature reaction.

The design of a machine that has to carry full kva. lagging or leading becomes, for the foregoing reasons, necessarily a compromise and its armature reaction is chosen smaller than it would be for a condenser or a reactor. Its air gap is chosen longer than that necessary for a condenser, but shorter than that which would be used for a reactor and this results in a larger and more expensive machine. In predetermining the characteristics corresponding to reactor or condenser operation, it should be borne in mind that the saturation curve corresponding to lagging-kva. operation differs from that for condenser operation, on account of the influence of the rotor leakage flux.

For condenser operation the voltage generated depends upon the flux that crosses the air gap and links the armature windings, which is the total flux minus the rotor leakage flux. The influence of the latter is limited to the saturation of the rotor iron. During reactor operation when the excitation is furnished either altogether or mainly by the armature winding, an additional voltage is induced by this leakage flux which links the armature windings, and as a consequence less saturation exists in the magnetic circuit for a given terminal voltage during reactor operation than is the case when the machine operates as a condenser.

In conclusion, the effect of a modifier upon a power system may be summarized as follows: (1) The improved voltage regulation insures better service, simplifies the operating problems, permits line extensions that otherwise would be impracticable, increases the safety of operation by decreasing insulation strains. It also permits close setting of the protective apparatus. (2) Power-factor improvements release system capacity and reduce system losses, both of which result in reduced power cost. (3) The inertia of the rotation parts of the modifier will improve the speed regulation of the prime movers on the system.

A Gas Engine with Maximum Efficiency

By H. Wieland Los

The utilization of the waste heat of gas and oil engines in this country has been restricted to a few insignificant applications, and none of these has been a pronounced success. In 1908 the exhaust of a new 400-hp. double-acting producer-gas engine was directed into the heating system of a textile mill, but the management was compelled to install a low-pressure heating boiler, inasmuch as it took too much time to heat the mill to the desired temperature level, and the supply of exhaust-gas heat was cut off. Up to date this has been the most important application in Holland.

I have devoted some thought to the subject and reached the conclusion that the waste heat of suction-gas producer engines should be applied to enable the engine to carry a constant overload.

The output of a producer gas engine of the suction type will be considerably increased if fed with Dowson gas. In fact, in one instance I noticed an increase of 66 per cent. However, a Dowson gas plant is somewhat complicated; a small steam boiler for producing the blast is necessary and all joints must be made very tight in order to prevent the escape of the poisonous gas, but that is an easy matter to take care of by modern design.

I suggest that a suitable steam boiler be connected directly to the exhaust of the engine, thereby producing steam of 45 lb. pressure at a rate of about 2.5 lb. per brake horsepower. If the fuel consumption of the engine is 1¼ lb. per brake horsepower, 2 lb. of water is evaporated for every pound of coal fed into the producer. As the Dowson plant needs 1 lb. of water per pound of coal used, there remains a margin of 50 per cent when the suction plant is converted into a Dowson or pressure gas plant. In other words, there is ample steam available for producing a blast to force the gas to the engine, and increasing the volumetric efficiency of the engine. The steam blast works continuously, thus the efficiency of the producer will be increased, and in addition, as a greater part of the steam is decomposed into oxygen and hydrogen, the fuel value of the gas will be increased. Moreover, it is now possible to fire one of the finer grades of coal which are procurable at a low cost.

The proposed arrangement will work entirely automatically. Steam is raised only when it is needed and the regular vaporizer which is fitted to the suction gas producer, can be used as a preheater for the waste-heat boiler feed.

Needless to say, all passages should be made as short and direct as possible and the radiating surfaces insulated. If desirable, the steam can be superheated by means of the exhaust gas, the superheater being fitted behind the waste-heat boiler.

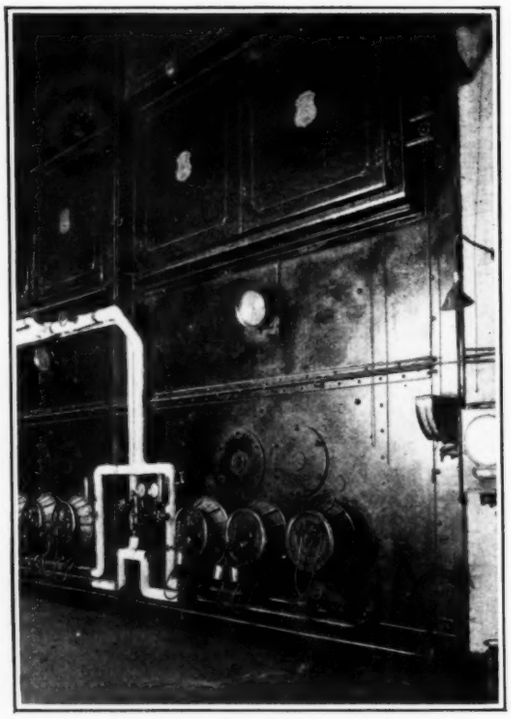
If 50 per cent of the heat of the fuel passes out through the exhaust of the average gas-engine plant, it should at least be possible to recover 25 per cent by means of this simple arrangement, making the engine efficiency as high as 35 per cent.

Centrifugal pumps sometimes will pick up water for a few seconds, as shown by the discharge gage, and then lose the suction when the discharge valve is open. The reason for loss of suction generally is a large amount of air which is drawn in through the glands or suction pipe in some way. Air sometimes may be drawn in through the suction pipe, although it is entirely submerged beneath the level of the water. This is due to some extent to the vortex or whirling of the water around the suction pipe, thus forming an open passage to the air above. The cure lies in reducing the velocity of water in the suction pipe, either by adding a bell-mouth or tee, etc., or by drilling a number of holes into this pipe.—*J. S. Pillans.*

Errata—In the article on "Deep Well Water Pumping" by G. B. Mulloy, June 23, 1925, issue, pp. 992-94, the following corrections should be made: The depth of the power-house well is 1,585 ft. instead of the 158 ft. given in the text. The Packers Avenue well was drilled, rather than deepened, to meet the growing demand for artesian water, and in this well the depth of the suction inlet below the static water level was 84 ft. instead of 300 ft., as given in the first column of page 993.

The smoke problem is still with us. At the recent meeting of the National Academy of Sciences reported in the May 8 issue of *Science*, Dr. George T. Moore, of St. Louis, said that if the body retained all the soot and dust breathed in, the average city dweller would gain 25 to 35 lb. of weight each year.

Power Plant of James A. Hearn & Son Department Store



Above—Two of the water-tube boilers are equipped with mechanical oil burners

Below—Main unit is a 28x36-in. Skinner universal unaflow direct-connected to a 600-kw. 250-volt direct-current generator

Modern Equipment Makes Remarkable Saving

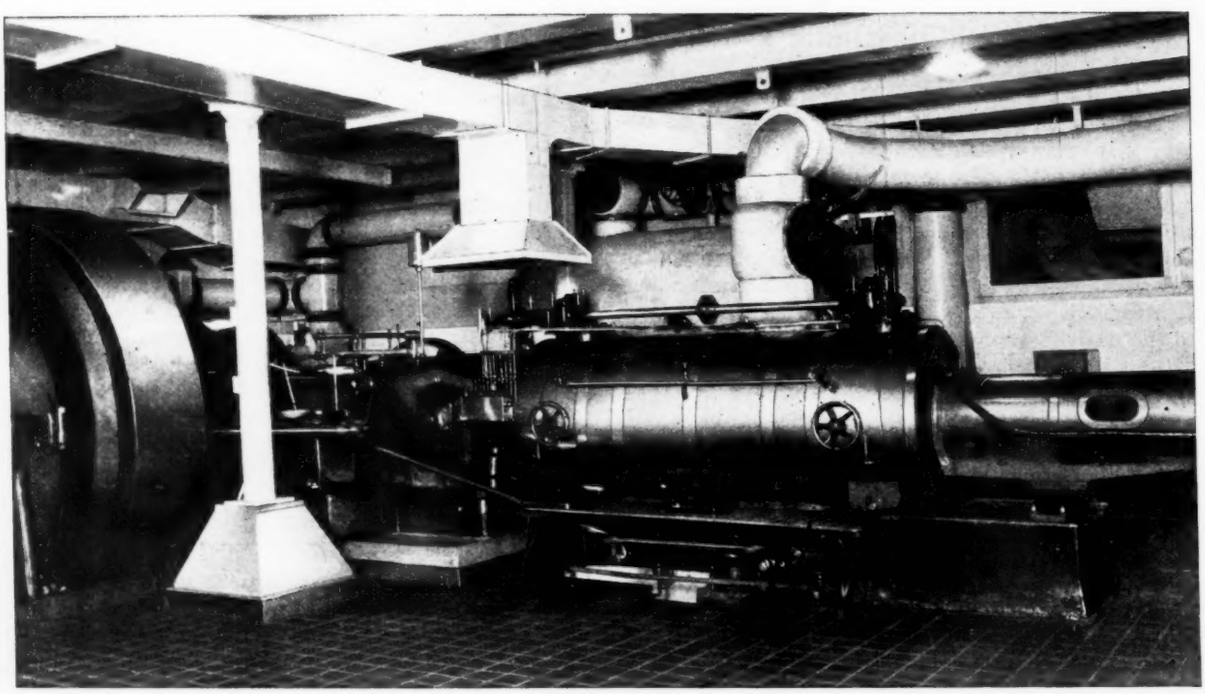
ORIGINALLY, this New York department store had eight return-tubular boilers in the power plant. High-speed engines were loaded to the point where the exhaust supplied the heating demand (about 31,000 sq.ft. of radiation); the rest of the power was purchased.

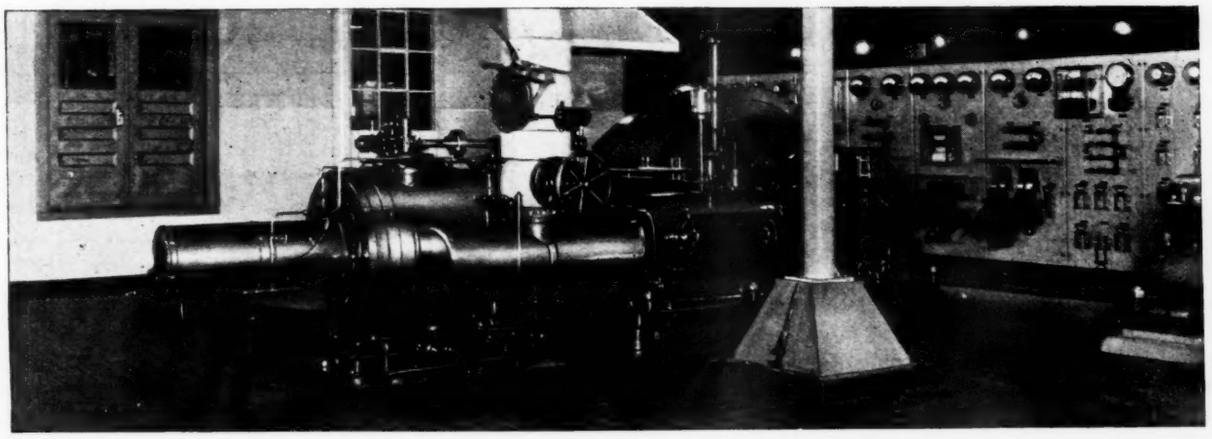
Four water-tube boilers were installed, two being stoker equipped and two fitted with oil-burning equipment. A 600-kw. and a 250-kw. unaflow engine were installed. The engine builder guaranteed a saving of 42 per cent over the former cost for power and heat. One year's operation showed a saving above this percentage.

The fact that the plant is provided with both coal- and oil-fired boilers gives great flexibility. The swing from coal to oil or vice versa can be made in six hours. At present No. 3 buckwheat is being burned.

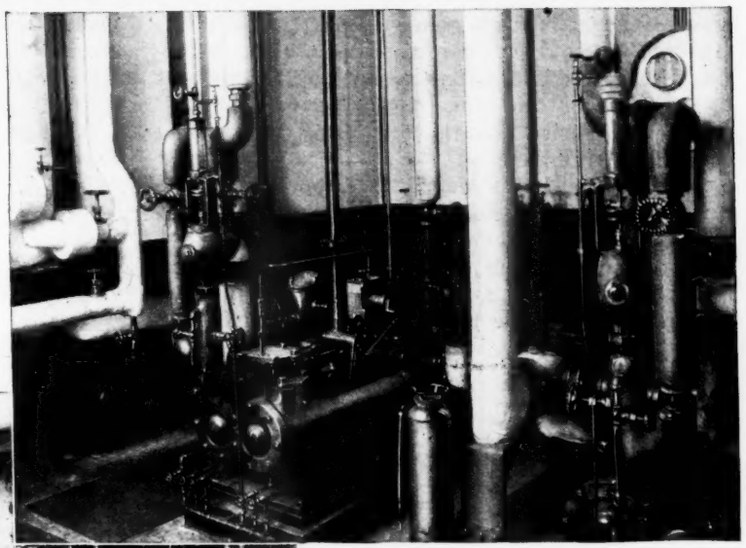
Live steam is metered to engines and to various store departments including kitchens, cafeteria, tailor shop, etc. Accurate plant records are kept so that the management knows what power and heat is costing.

Power and heating services are extended to an apartment house and several buildings in same block as the power house.

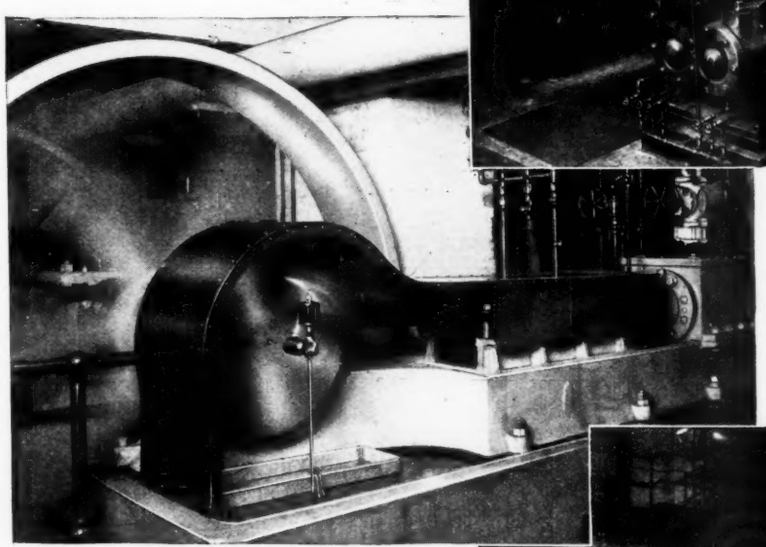




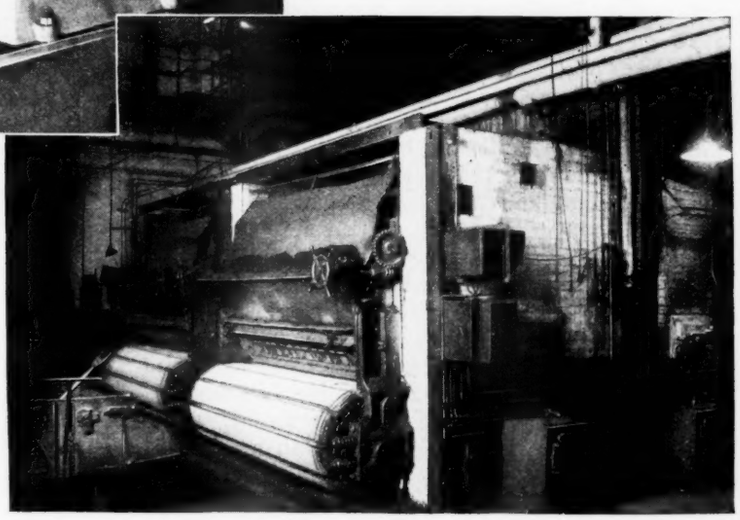
Above—250-kw. engine-generator set carries night and holiday load



Right—Oil pumping equipment consists of duplicate duplex steam pumps and one electric pump for light oil service, two storage tanks, primary and secondary heaters and twin oil strainers



Left—Two belt-driven ammonia compressors supply refrigeration to the kitchen, restaurant, drinking-water system, fur storage and other departments



Right—No. 3 Buckwheat is burned on forced-draft chain grates. Air Flow-Steam Flow meters are used on all boilers

Shell-and-Tube Type Ammonia Condensers—Design and Methods of Construction*

By L. H. BURKHART†

IN THE design of a shell-and-tube type ammonia condenser the first consideration is the capacity of the condenser. This is usually expressed in tons of refrigeration per 24 hours and that again in square feet of cooling surface. This capacity is usually determined by the size of the plant into which the condenser is to be installed. Without going into technicalities as to the number of square feet required per ton of refrigeration, the generally accepted average of 12 sq.ft. of cooling surface per ton of refrigeration will be used and it will be assumed that the requirements are for a 100-ton condenser.

The most economical size of tubes, taking cost of cooling surface into consideration, has been found to be 2 in. in diameter. There is a manufacturing economy in the use of this size as well, as will be seen from Table I, which gives size, length of tube per square foot of surface, list price per lineal foot and cost per square foot of surface:

TABLE I—COST OF CONDENSER TUBES

Size In.	Length of Tube per Square Foot Mean Surface	List Price per Lineal Foot	Cost per Square Foot at List
1¾	2.3	$0.22	$0.506
2	2.0	0.21	0.42
2¼	1.775	0.24	0.428
2½	1.6	0.30	0.480

It appears that a square foot of cooling surface is cheapest in the 2-in. tube. The ease with which 2-in. holes can be drilled in a tube sheet and the tube rolled into the hole are other considerations in favor of using

Impurities in Cooling Water Corrode Tubes

In most localities the cooling water is impregnated with impurities that pit and corrode tubes, so it has been found advisable to select tubes of the proper material and gage to last for a long period of time. It has been demonstrated that genuine charcoal iron tubes of 12 to 10 gage fill these requirements satisfactorily; in some places where conditions are extremely bad, 9 and 8 gage tubes are specified, but these heavy tubes are somewhat difficult to expand tightly in the sheets.

We have assumed the design of a 100-ton condenser having 12 sq.ft. per ton and using 2-in. tubes, which call for 2 lin.ft. of tube per square foot of surface. As a rule it is not advisable to use tubes longer than 20 ft. for reasons of manufacture of tubes and because of the excessive amount of expansion and contraction that will be set up in long tubes. Better results in cooling also can be obtained by using shorter tubes. When long tubes are used, the cooling water which enters as a film around the tube at the top becomes of the same temperature as the hot ammonia gases before it has passed entirely through the tube, so the lower end of the tube may not be effective. Therefore, a shorter tube will do as much work as the long one. Other conditions, such as headroom, must be considered in choosing the length of the tubes.

If the tubes are selected relatively short, say 10 ft. for example, then to get 2,400 ft. of tubes into the condenser the diameter of the shell and area of the tube sheet become large and excessive dimensions in the

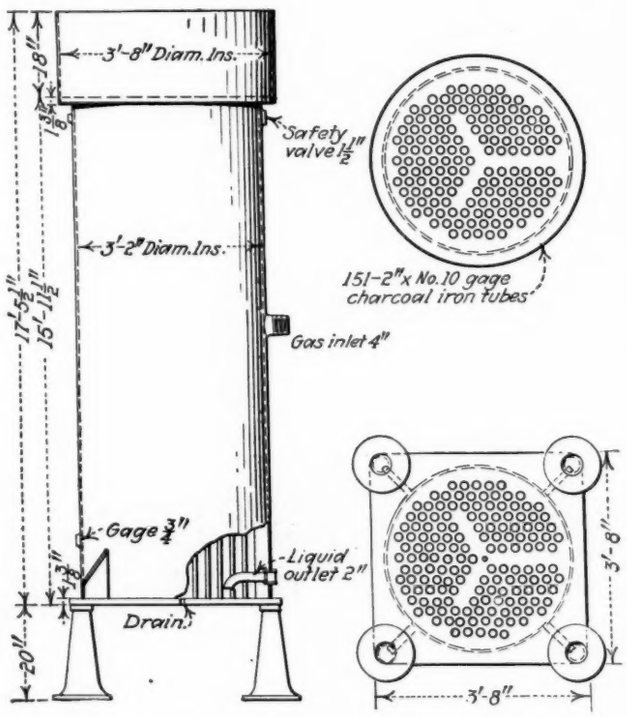


Fig. 1—Modern shell-and-tube condenser

thickness of shell result. It is, therefore, quite evident that some happy mean must be selected where all parts involved will be the minimum in material and manufacture and where the condensing efficiency of the tube surface is the best.

Next to be considered is the tube layout. The first consideration is to have sufficient metal in the bridges, the spaces between the tube holes, so that they will not spring when the tubes are expanded into the tube sheet. These spaces of metal must be wide enough to allow for flaring the ends of the tubes without the tubes touching each other and for space in which to install water distributors. The minimum space or bridge is considered to be ½ in. of metal. Since the tube holes are drilled 3/32 in. larger than the tubes, which are 2 in. outside diameter, the minimum spacing of

*Paper presented at the Western Meeting of the American Society of Refrigerating Engineers in Milwaukee, Wis., May 20, 21 and 22, 1925.

†Chief Engineer, Struthers-Wells Company, Warren, Pa.

tubes, center to center, is $2\frac{17}{32}$ in. A slightly larger bridge is better, since it affords more space for the ammonia vapor between the tubes and strengthens the tube sheets, consequently $2\frac{5}{8}$ in. will be taken as the proper tube spacing.

It has been found desirable to leave a passageway between the rows of tubes opposite the ammonia vapor inlet, leading to or past the center of the condenser. This passageway will result in the omission of several tubes and must be taken into consideration in making the tube layout.

As shown by Fig. 1, a 38-in. diameter circle will inclose 151 tubes, and the 100-ton condenser should be 38 in. in diameter by 15 ft. $11\frac{1}{2}$ in. long over tube sheets and contain 151 tubes, each 2 in. in diameter and 16 ft. long.

The next step is to determine the thickness of the shell and tube sheets.

The maximum working pressure will be taken as 250 lb. per sq.in.; the longitudinal seam of the shell will be electric-arc welded inside and outside, the joint having an efficiency of not less than 80 per cent; boiler flange steel with ultimate tensile strength of 55 to 65,000 lb. per sq.in., an elongation of 25 per cent in 8 in. and a reduction of area of 50 per cent will be used.

The formula for calculating the thickness of cylindrical shells is:

$$PRF = TSE$$

where P = pressure, R = radius of cylinder, F = factor of safety, T = thickness of plate, S = tensile strength, E = efficiency of joint.

We therefore have

$$T = \frac{PRF}{SE}$$

Substituting values,

$$T = \frac{250 \times 19 \times 5}{55{,}000 \times 0.80} = 0.55$$

This is so near $\frac{9}{16}$ in. that the latter value will be taken for the thickness of the shell.

Points To Be Considered in Deciding the Thickness of Tube Sheets

In deciding on the thickness of the tube sheets, several important factors must be considered. The tubes must be made tight and must hold in the tube sheet by friction. Sufficient surface must, therefore, be provided to set up this friction. It has also been found advisable to groove or counterbore the tube holes at the center of the tube sheet, and space must be provided for the groove while still leaving a liberal amount on each side of the groove. The smallest effective groove that can be cut is $\frac{3}{8}$ in., and about $\frac{1}{2}$ in. of space each side of this groove is needed; the sum of these three figures gives $1\frac{3}{8}$ in. for the thickness of the tube sheets.

The upper tube sheet is made 6 in. larger than the diameter of the shell to form the base of a water box, and the lower tube sheet is made square, usually 6 in. larger each way than the diameter of the shell. The corners, after being rounded off, furnish means for supporting the condenser on supports or jacks. A gusset of $\frac{1}{2}$-in. plate is welded on the corners between the tube sheet and the shell to render the corners of the tube sheet rigid enough to support the weight of the condenser without deflection.

A water box, usually 6 in. larger in diameter than the shell and from 18 to 24 in. deep, is provided. This box is for the purpose of holding a supply of water from which the feed for the tubes is taken.

A distributor is inserted in the top of each tube for the purpose of filming the water down the inside surface. These distributors have been made in a variety of designs, from a galvanized ferrule with a serrated top to a conical stop suspended in the tube from its flared top; also with a fixed peripheral orifice and with an adjustable orifice, all of which accomplishes results in a more or less satisfactory way.

The plate to form the shell will be in the rough 190 in. by 122 in. by $\frac{9}{16}$ in. The top tube sheet will be $44\frac{1}{2}$ in. in diameter by $1\frac{3}{8}$ in. thick, and the bottom tube sheet will be $44\frac{1}{2}$ in. by $44\frac{1}{2}$ in. by $1\frac{3}{8}$ in. There will be one longitudinal and two girth seams.

By referring to Fig. 2, the details of these seams can be seen. The plate for the shell is planed along its edges to exact size and beveled to form a 60-deg. V-joint for electric welding. The sides which will form the ends of the cylinder when rolled up are beveled back so as to form an angle with the tube sheets of about 60 deg. The tube sheets are turned and planed around

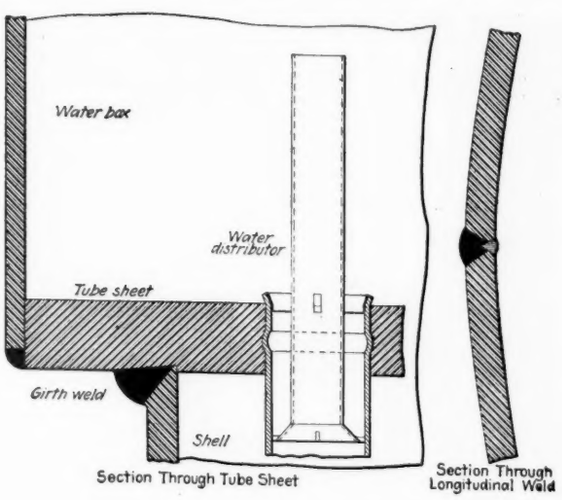


Fig. 2—Details of welded joints

their outer edges to size, and a chime is turned into each for the reception of the ends of the shell and to afford a clean metal surface for welding.

The tube sheets are laid out for the correct number of tube holes and their centers prick-punched. A $\frac{3}{4}$-in. pilot hole for each tube hole is drilled through the heads when the latter are assembled in pairs. This is found advisable, owing to the fact that a $2\frac{1}{32}$-in. drill does not drill a true hole when used without the pilot hole. Besides, the drilling with the $2\frac{1}{32}$-in. drill can be done faster after the pilot hole has been made.

After the $2\frac{1}{32}$-in. holes have been drilled, a special tool for counterboring is used to ream out the groove at the center of the sheet in each tube hole.

All openings having been located and punched or drilled in the shell plate, it is rolled and clamped securely. The long seam of the shell is adjusted so that at one end the two edges of the plate are about $\frac{1}{8}$ in. apart and at the opposite end the seam is open an amount equal to about $\frac{1}{8}$ in. per foot of length, or about 1 in. for the case in hand. This arrangement of the seam for welding is not absolutely necessary, since the edges may be brought to each other parallel and tacked in this position and welded. How-

ever, a seam welded with the first scheme of assembly is freer from locked-up stresses than it would be by using the latter scheme.

Welding the Long Seam

The long seam is welded by running one string of welding the full length outside. Then if the plate is ½ in. or thicker, a second string is placed over the first string of welding. The imperfectly united edges of the shell plate on the inside are chipped out with a diamond-pointed tool and a third string of welding run on the inside, each side being built up about 10 per cent. A weld thus made will not leak under pressure, for there are no pinholes completely through the seam and the welded seam will be stronger than the plate.

All connections, such as nipples, couplings and pipe bushings, that require welding from both sides, are inserted and welded into place. The tube sheets are then assembled at the ends of the shell and drawn into the chimes, cut for them, by through bolts and nuts operating through the tube holes of the tube sheets. When this assembly is completed, the through bolts are allowed to remain in place while the welding of the shell to the tube sheet is being done. This is done by using two or three strings of welding. There is a tendency of the girth welds to dish the tube sheets out at their centers. This strain is counteracted by the through bolts which remain in place until the welding of the girth seams is done.

The tubes are inserted and rolled tight and flared by a power-driven expander. A second rolling operation, with a special beaded roll, is done to roll the tube into the recess of the tube hole. If there is any tendency of the tube, by contraction and expansion, to slip through the tube sheet, it at once tightens up on the conical surface of the recessed tube sheet in either direction.

Testing the Condenser

The condenser is now ready for test. This is done by filling the space around the tubes with water and a pressure of 500 lb. per sq.in. pumped up. Any leaks that may show up in the tubes and tube sheet are tightened up by rerolling while under this pressure. The pressure is allowed to remain on until the inspector is satisfied that the job is tight.

Some engineers specify an air test under water. Such a test for a condenser is not practical, for while the leaks may be located, it is difficult to mark them and they cannot be repaired under water, so the condenser has to be removed from its bath. If the leaks could be marked properly and stopped, then a re-immersion of the condenser would have to be made, all of which means disconnecting pipes, the use of a crane and a lot of time wasted before the condenser is tight. Such a process of testing is anything but satisfactory.

After the test is completed, the water-box shell is welded in place, the condenser cleaned and openings plugged and the shell painted outside, after which it is ready for shipment.

While a satisfactory welding code has not yet been published, and the insurance companies have not yet fully agreed to accept electric-welded joints for insurance, yet an electric-welded joint, when made in a first-class shop, is as strong and as safe as any other type. Test samples demonstrate this fact. Anyone who is familiar with electric welding has no doubts about its efficiency. It is being advocated by the writer because it is as safe as other joints, is tight against leaks and is much cheaper than hammer welding or butt-strap riveted joints. It has many advantages for the manufacturer, and the results of these advantages, as reflected in cost and efficiency, are passed over to the consumer.

Cost of 60-Cycle vs. 25-Cycle Equipment

In discussing equipment for steel-mill power plants, the following figures were recently given by Barton R. Shover before the A.I.S.E.E. Figures on duplicate equipment of different-sized units of each class were obtained from various manufacturers, the average being as follows:

COST PER KW. OF RATED CAPACITY

	25 Cycle	60 Cycle
Turbo-generators	$19.33	$17.00
Motor-generators	19.60	18.35
Transformers	2.47	1.56
High-voltage motors for mill drive	13.49	10.62

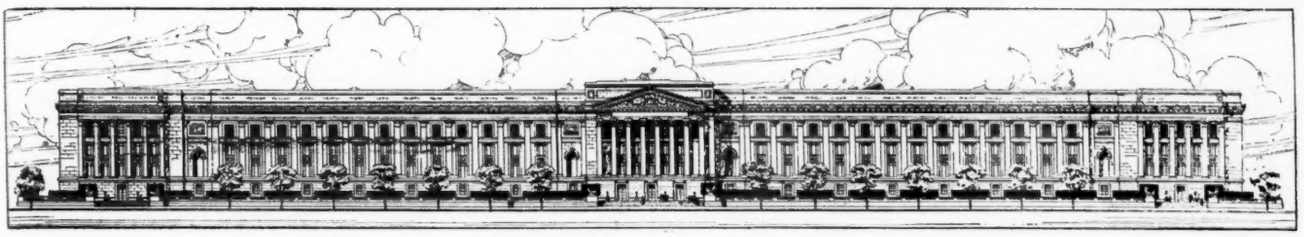
These prices do not include such items as foundations, installation, condensers, etc., which would be the same for both frequencies.

No figures were made concerning low-voltage auxiliary motors, the cost of which is considerably in favor of 60 cycles.

A simple method of finding the approximate current pulsation in motors driving ammonia and air compressors has been suggested by W. W. Pratt, of the General Electric Co. The method is as follows: Remove the cover of the switchboard ammeter; with a pencil push the needle slowly upward along the scale to a point where the needle no longer jumps away from the pencil; read this point as the maximum amperes; then slowly push the needle to the bottom of the scale and move back up the scale until the needle just starts to jump away; read this as the minimum amperes; subtract the minimum from the maximum, divide by the motor rated current. This will usually be closely 90 per cent of the results obtained by an oscillograph, when the line current does not reverse. If the low reading is zero, the current either just comes to zero or it reverses, and it is not wise to rely on this method for such cases. There are errors that may enter this method, but where it does not come fairly close to what is anticipated, a further more thorough investigation would be warranted. This is not an accurate method but is being offered as an assistance in meeting the pulsation rules. The damping of the meter should make little difference.

The temperature at which the oil refuses to pour when a test tube of the oil is inverted 135 deg. is termed the *pour point*. This is of importance to the engineer as a means of judging the suitability of the oil for temperature work, such as the lubricating of refrigerating compressors or bearings out of doors in winter. For example, an oil that congeals at 20 deg. F. would be unsuited for an ammonia compressor where a zero suction temperature is carried.

The water of the measuring burette (of an Orsat) should be colored with methyl orange and a few drops of sulphuric acid. This not only gives it a red color, which is more easily visible, but if by any accident a little potash is splashed over into it, which would give erratic results by absorbing part of the CO_2 during sampling, the change of color to orange will immediately call attention to it.—*H. D. Fisher.*



The National Museum of Engineering and Industry

By I. S. PROPER

SCATTERED about in the United States in small institutions, clubs, educational establishments, governmental departments, the Patent Office, business and industrial concerns and in private custody, stowed away in boxes, hid in moldy cellars and dusty attics or even in junk heaps, are the models and records of outstanding inventions of America. These inventions have made possible the marvelous mechanical progress that is the boast and glory of America today.

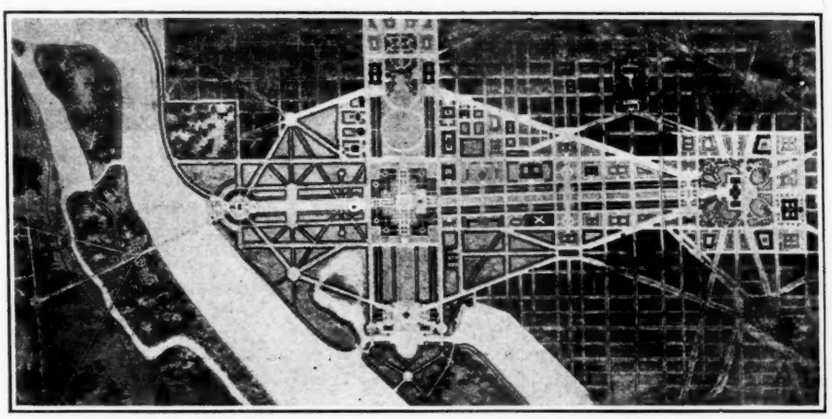
To provide a permanent home for these precious heirlooms which have made this young nation important, a group of nationally known men, engineers and industrialists, formed a society which was incorporated in 1924, whose purpose is "to establish and maintain a permanent organization and home for commemorating the achievements and perpetuating the records of engineering and industry."

This home is to be called the National Museum of Engineering and Industry, to be under the direction of the Smithsonian Institution at Washington, D. C. Provision has also been made for local and smaller branches in the large cities, where replicas of the fundamental mechanical principles from all sections of the world will be placed for the convenience of students and workers.

America, whether due to its youth or its absorption in the rush and whirl of the exciting and breathless cycle in which it has found itself, has heretofore displayed little reverence for the great discoveries of the immediate past and has shown scant interest in preserving for future generations the records of the beginnings and gropings of those whose enterprise and genius made possible the gigantic development in industrial lines upon which we are so largely dependent. Yet every day news is had of American expeditions, richly endowed, busily engaged in digging and delving into the ground in search of the records of the achievements of the ancient peoples of the earth, and of the sacred care given these objects, the careful cataloging, the mounting and placing in museums by experts who take as an every-day matter the modern inventions they use in connection with the excavation of such objects and the chemical research which preceded the methods used by them for the preservation of these treasures. The world seems utterly oblivious to the fact that the history and development and beginnings of these instruments upon which all modern life is based go unrecorded and forgotten. Yet time in its unyielding and immemorial way will eventually blot out these records and destroy the models, and they will be lost to the future generations unless they are preserved in a permanent place such as only a national museum, under the wing of the government, offers.

The site chosen for the engineering museum is on the Mall in Washington, alongside similar governmental buildings. The type of building desirable for the purpose and which meets with the approval of the authorities is shown in the sketch at the top of this page. This building will be built from plans resulting from an architectural competition. Ten million dollars for the initial establishment is the goal of the committee in charge of the plan. One million is already promised.

Samuel Insull, president of the Commonwealth Edison Company of Chicago and well-known leader in utility fields, was recently chosen as president of the corporation, and undoubtedly under his efficient guidance great progress will be made toward the establishment of the fund and the maturing of the project. Mr. Insull, in addressing the formal gathering that marked his inauguration into office, said that many museum specimens had been collected and that the problem had been where to put the collection. "They needed," he



View of plan of Washington, D. C. showing the Mall. The location on it accorded to the Museum of Engineering and Industry is marked by an X

said, "the support of the great engineering societies and their memberships, the co-operation of the country's manufacturing industries and the assistance of educational institutions to make the museum the success hoped for." Mr. Insull said:

"This is not a scheme of any particular group or of any particular industry. It is one that should, and doubtless will, interest all the engineering organizations and industries of the country. We need money, more members of our association, and a guarantee fund to cover the expense of obtaining subscriptions for the institute. If the Government provides the site and we make a determined effort to provide the building, no doubt the Congress of the United States will assist us in the rest."

Samuel Insull, President of the Museum of Engineering and Industry

He suggested an endowment method of maintaining the museum after its establishment. The Board of Trustees held a session after the luncheon to consider steps in the campaign that will probably be inaugurated shortly as a general movement to raise the desired funds.

The idea of establishing this engineering museum came through the activities of a group of men belonging to the Associated Veterans of the DeLamater Iron Works. They were banded together to preserve the fame and works of Capt. John Ericsson and Cornelius H. DeLamater, those virile engineers of Civil War times who created the old "Monitor" and other notable works. After placing tablets commemorating the accomplishments of these men on various buildings, on the sixtieth anniversary of the battle of the "Monitor" and "Merrimac" in Hampton Roads, they had a small sum left which they applied toward collecting records and historical material connected with these men. A sizeable collection was gathered together, but there was no permanent place in New York City for it, so the Smithsonian authorities were appealed to and through the resulting negotiations the idea of this great museum was born.

H. F. J. Porter, secretary of the museum organization, who was also chairman of the Ericsson committee, has been indefatigable in his efforts to establish a permanent museum and to collect material appropriate for it. He can be addressed in care of the A.S.M.E., 29 West 39th St., New York City.

What we in America have failed to do in the way of preserving records and models of objects through which the development of modern mechanisms can be traced, other countries have been industriously gleaning, and to their collections at present the American students and workers have to turn for material needed for research.

H. F. J. Porter, Secretary of the Museum of Engineering and Industry

England around 1910 segregated the machinery and scientific apparatus that had slowly been collecting in the South Kensington Museum for many, many years, and established the Science Museum near-by where machinery in motion and models of inventions are shown in splendid fashion.

A hand press said to have been used by Benjamin Franklin, the original model of Nasmyth's steam hammer, a collection of steam engines among which are the Newcomen engine as it was in 1720, "Old Bess" and the engine of 1777 which replaced the engine which James Watt applied for the first time to his separate condenser, Watt's first sun-and-planet engine, models of his beam engine worked by compressed air, his attic workshop reproduced faithfully with the real tools and objects it contained at his death, historical series of locomotives, including the "Rocket" and "Puffing Billy," of Stephenson, gas engines, motors, dynamos, a model of the Thornycroft-Schulz water-tube boiler of 1909, apparatus used by Joule, Kelvin, Crookes, Trevithick and others—these are some of the treasures of the Science Museum which are an inspiration to young engineers.

France in 1794 established her Conservatoire National des Arts et Métiers at Paris which records French industrial progress. It is especially distinguished by its complete and graphic record of the development of industrial accident prevention and safety devices. The museum has over 15,000 original inventions, models and devices that established successive steps in industrial evolution. This museum contains the first tubular boiler constructed by Marc Séguin in 1877 and the apparatus with which Lavoisier decomposed water.

Austria has its great industrial museum in the Technisches Museum at Vienna which is one of the most modern of museum institutions in the world. It is a center for study and research along engineering and industrial lines and was opened to the public in 1922.

On May 7 of this year the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik, which is the full name of the institution in Munich, Germany, was opened with great enthusiasm by the German people, after twenty years of stubborn work on it, as its corner stone was laid in 1906. This museum is dedicated to the subject of the rise and progress of engineering and applied science and closely resembles the South Kensington Museum in England. One large hall is given over to models of early prime movers.

The Deutsches Museum, which is not a state institution, has largely been built up by the foresight and

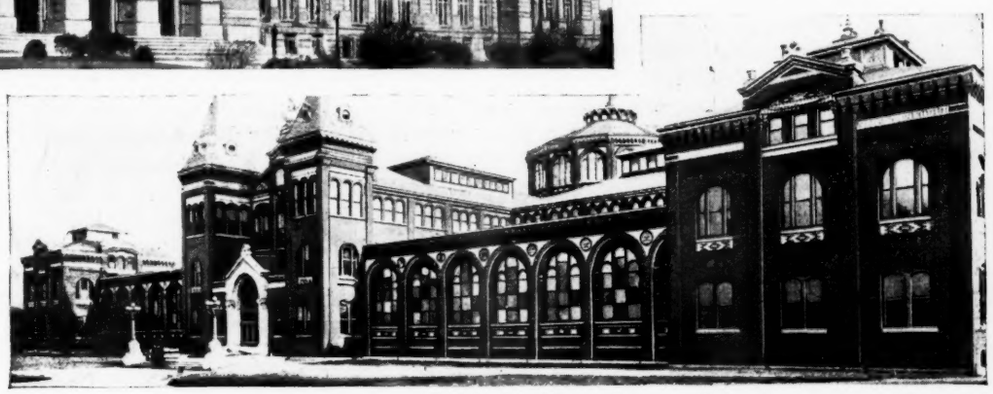
Below—Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik, Munich, Germany. The building at the right is the only one so far erected

Above — Science Museum, South Kensington, London, where records of English accomplishments are exhibited

Right — Conservatoire National des Arts et Métiers at Paris, France. This museum was established in 1794

Left — Technisches Museum, Vienna, Austria. This is a modern museum, having been opened in 1922

Right–United States National Museum, Arts and Industries Building



wisdom of Dr. Ing. Oskar von Miller, a well-known consulting engineer, who is consultant to the Walchensee Kraftwerk, a power scheme fast approaching completion, which will supply Munich and a large part of Bavaria with power, light and heating. His seventieth birthday occurred on the opening day of the museum. The museum has an ideal location on an island in the Isar. Only part of the building is completed. The plans call for a building to cover the entire island.

The provisions thus far made in the United States for preserving a living record of America's industrial development are inadequate. The United States National Museum, which is the only repository of national objects of engineering and industrial progress now in existence, is a branch of the Smithsonian Institution and was built up around the collections of the Patent Office which were turned over to it in 1858 and those of the National Institute, dissolved in 1861. A part of this collection was destroyed by fire in 1865. The small collection that remained was principally of art objects and was exhibited in the Corcoran Gallery until 1896, later being turned over to the National Gallery of Art, also a branch of the Smithsonian Institution. This has been considerably enlarged by famous bequests.

The Act creating the Smithsonian Institution provided for the delivery to the Board of Regents, and the maintenance of buildings which were to be erected according to the Act, of "all objects of art and of foreign and curious research and all objects of natural history," belonging to the United States.

Naturally, under the provisions of this Act collections of natural history, researches and explorations of various kinds, art and art in industry would receive quite properly more important attention than inventions and progress in industrial machinery and engineering.

The present government exhibits in its Art and Industries Building include important displays of minerals, mineral technology, textiles, firearms, boats, railroad models, electrical apparatus, musical instruments, ceramics, graphic arts and photographic progress. These exhibits will be expanded when incorporated into the new museum.

The scientists whom the government has at the head of its museum work are in hearty accord with the projected Museum of Engineering and Industry, and it now remains for the engineers, industrialists, inventors and students to get behind this movement and bring it to a speedy fruition.

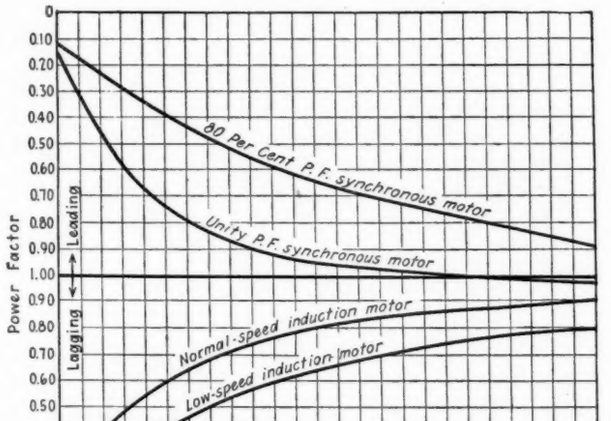
Synchronous Versus Induction Motors

When considering a comparison of the characteristics of a synchronous motor with those of the induction type, there are a number of elements other than power factor that should be included, such as starting, pull-in and pull-out torques, inrush current, efficiency, etc. But power factor is one element that offers a greater contrast than any other, as indicated in the figure. The power factor of a synchronous motor, might be said to be inherently leading, although it can be adjusted, where the power factor of an induction motor is inherently lagging and cannot be adjusted.

Synchronous motors are in general designed for unity power factor or for 80 per cent leading power factor at full load. This means with normal excitation current through the field coils and full load on the motor, the power factor will be either one of the values stated, depending upon the design of the motor. If the field current is reduced below normal on the unity-power-factor motor at full load, the power factor will become lagging, which would also be the case for the 80 per cent power-factor motor if the field current were reduced far enough.

Adjusting the field current to normal value and leaving it at this point, the power factor will swing to leading values as indicated in the figure. For example, the unity-power-factor motor at 50 per cent load will have a power factor of about 0.92, and the 80 per cent power-factor motor will have a power factor of about 0.59 leading. At 25 per cent load these power factors become 0.75 and 0.40 respectively.

Considering the power-factor curve of the average induction motor, it is around 87 per cent lagging at full load; at 50 per cent load the power factor will decrease to about 0.77 lagging, and at 25 per cent load



Curves show relation between power factors of synchronous and induction motors

the power is about 0.60 lagging. These values are for the average motor designed for a normal speed. For high-speed motors the full-load power factor may be slightly better than 0.90, where for slow-speed machines the full-load power factor may be around 0.77 and the part-load power factors are proportionally less.

It is in the slow-speed machine that the synchronous motor compares most favorably with the induction type. Not only is the efficiency of the slow-speed synchronous motor higher than that for the induction type of the same speed and size, but the power factor of the former can be made almost any desired value.

The figures show that the power factor of an induction motor decreasing to lagging at about the same rate that the 80 per cent synchronous motor decreases to leading, as the load is reduced and where both types of motors are on the same system, the synchronous motor will tend to correct the lagging power factor of the induction machines. This is a distinct advantage on most systems, since, on account of the number of partly loaded induction motors in operation, the power factor is lagging. Even if the synchronous motor is loaded, it will have a corrective effect on the power factor of the system; as the load is decreased on the motor this corrective effect is generally increased.

Improved Industrial Plant Economy

ALTHOUGH the attention of engineers has been attracted to large stations recently placed in operation where high pressures, stage bleeding and reheating represent the latest advances toward improved economy, nevertheless it should be realized that the industrial plant has by no means been standing still.

A small factory plant containing a five-hundred-kilowatt non-condensing turbine recently placed in operation and described in the June 9 issue produces a kilowatt for around eleven thousand British thermal units when credit is allowed for the exhaust steam, which is not bad for average operation at an initial steam pressure of one hundred and seventy pounds. A high back-pressure unit of ten times this capacity has been operating at seventy-five to eighty-five per cent Rankine ratio efficiency. This is on a par with the performance of the largest prime movers.

Large modern central stations range from fourteen to twenty thousand heat units per kilowatt-hour, whereas the industrial plant, when exhaust or back-pressure process steam is usable, can produce a unit of power for about half the fuel required by a pure energy-cycle station. For this reason manufacturers who use sufficient process steam should make a careful study of their conditions and the possibilities of saving before deciding whether to purchase current or install a private plant.

A Much Needed Feed-Water Study

THERE is probably no phase of power-plant operation about which the average engineer knows less than feed-water treatment. This is no indictment of his operating ability, for the problem is frequently one that warrants the attention of the specialist, although the latter is too seldom consulted. Yet an intelligent solution may mean large savings, through increased life of equipment, lessened maintenance and increased availability of equipment, not to mention decreased hazard from failure.

Waters of various localities differ as to their corrosive and scale-forming qualities and require treatment adapted to their constituents. Of the many processes of feed-water treatment that have been evolved, each is best adapted to waters possessing certain properties or percentages of makeup. There is no general panacea. Yet how often does one run across a plant employing some method of treatment whose selection was based solely on apparent satisfaction in another plant or upon the recommendation of a salesman.

Again, there are many points upon which even specialists are not in full agreement. These include, among others, the effect of hydrogen-ion concentration upon the precipitation of hardening salts; the relative value of continuous and intermittent softeners; the causes of corrosion where the water has been practically deaërated; the effect of CO_2 as a control factor in corrosion; and finally, the controversial subject of embrittlement, which some attribute to the presence of caustic soda and others contend is due to faulty material or excessive internal stresses set up in the process of manufacture.

Therefore engineers will welcome the program that has been outlined by the Standardization Council of the American Water Works Association for an exhaustive study of waters used for boiler feed. The study, which will be undertaken by an advisory committee and eight subcommittees, will be carried on jointly with the National Electric Light Association and the American Railway Engineers Association. The scope of the investigation and the personnel of the committees presage an authoritative and unbiased report which should be most useful to the operating or practicing engineer as a guide in dealing with a perplexing problem.

Too Much Left To the Human Element

THE report elsewhere in this issue of the failure of two penstocks at the Moccasin Creek power house of the City of San Francisco, again raises the question as to whether proper consideration is being given to the design of this part of hydraulic power developments and if too much is not being left to the human element in its operation. According to the report an operator opened the main gate valve in the penstock at the power house before opening the bypass and filling the penstock down to the nozzle. This being the case, the simple expedient of making the operation of the bypass and main valve interlocking would have prevented this accident.

The handling of large columns of water under high static heads requires great care if heavy surges are to be prevented. After a heavy surge has once been started, it is difficult to predict just what the outcome will be, but past experience has shown that it may result in a penstock failure. In fact these failures have occurred so frequently that one would expect that by this time factors of safety would be allowed in their design and safety devices introduced in their operation that would make such accidents practically impossible.

In the early days of almost any development the unforeseen is likely to happen. It is humanly impossible at first to predict all the conditions that will develop in anything so complicated as the operation of a hydro plant supplied through long penstocks under high heads. But we are now past the pioneer stage in these developments and know from past experience what can happen, yet some of the failures that have occurred in penstocks would indicate a lack of proper appreciation of the conditions that are known to exist in such plants.

A penstock cannot be designed as a boiler. In the latter a fixed pressure can be set as a limit and safety valves provided to keep the steam pressure from going beyond this point. Anything that may occur in the operation of the plant cannot seriously affect the pressure. In the operation of a hydro plant, unless the method of operation has been well worked out and incorporated in the design of the equipment, almost anything can occur in the penstocks and pressures build up until they burst. Therefore, before penstocks can be designed with the proper factors of safety, the operating conditions of the proposed plant must be established and the design so made that the fulfillment of these conditions will not be left to the human element.

With the operating conditions once fixed, the maximum pressures in the penstocks can be ascertained and used as the basis of the design with the proper factor of safety. If a penstock is designed for the static head on the plant, with a factor of safety of four, and the attendant can, in the operation of the station, cause the pressure in the penstock to double, the factor of safety is reduced to two, which, it must be admitted, is approaching the danger point. This shows the fallacy of designing a penstock on the basis of static pressure and also makes it evident that what can be done either by the turbine governor or the operator to disturb the normal condition of the column of water in the penstock must be known before a safe basis of penstock design can be established.

A Heat-Balance Principle Applied to Refrigeration

IN HEAT-BALANCE studies of steam power plants it has become an axiom that the greatest economy of fuel results from performing each heating operation with heat at as low a temperature as practicable. This is applied chiefly to the feed water, which in the newest stations, is heated first by low-temperature waste heat from oil and air coolers and thereafter mainly by bled steam at successively higher temperature levels. Except in the boiler itself there is no point in the system where a large quantity of heat is supplied to the feed water by a substance at much higher temperature. Since the low-head heat is worth less than high-temperature, inasmuch as it has less capacity for producing power, this plan of operation improves the over-all thermal efficiency of the station.

The same principle applies where steam is used for process work. The use of high-pressure steam from the boiler where exhaust steam would have a temperature high enough for the purpose at hand is a sheer waste of power-producing capacity. Still further thermal gain is possible where the exhaust steam can be replaced by condenser circulating water at a considerably lower temperature. Circulating water from condensers operating at moderate vacua is already in successful use for heating buildings, as is exhaust steam at pressures below atmospheric.

The converse principle of performing cooling operations in stages, using for each stage a cooling medium at as high a temperature as possible, has possibilities almost as great in the effecting of economies. While, scientifically, cold is not looked upon as an entity like heat, but merely as the absence of heat, the number of heat units per pound by which a substance falls below a certain standard may be looked upon as the content of cold per pound, just as the heat contained above that in water at 32 deg. is arbitrarily taken as the "heat content." Given a certain initial temperature of food or any other substance to be cooled, any other available substance at a lower temperature may be looked upon as a refrigerant. Even the air of a warm summer day is a refrigerant to the fireman who steps out of a sweltering boiler room.

Without being conscious of its scientific implications, the economical housewife makes daily use of this principle to keep down household expenses. If cooked food is to be chilled, she does not move it directly from the stove to the ice box, but first sets it in the window to be cooled to the air temperature. Thus she is carrying out the first stage of refrigeration with a "high-temperature" refrigerant which costs nothing. Sometimes she will use tap water (another refrigerant at somewhat lower temperature, and hence more valuable) for a second stage of cooling. The final stage is in the ice box where she must pay over four cents per thousand B.t.u. of cold, assuming that she gets her ice for sixty cents per hundred pounds.

This bit of household economy has been imitated in industry. Some of the city milk plants, for example, use cold well water for precooling milk before applying the more costly mechanical refrigeration. In one plant in New York City the wells supply water at fifty-six degrees F. during the summer when the average air temperature is above seventy degrees. Practically the only cost is that of pumping, which is small with shallow wells.

Keep the Ashpit Door Open

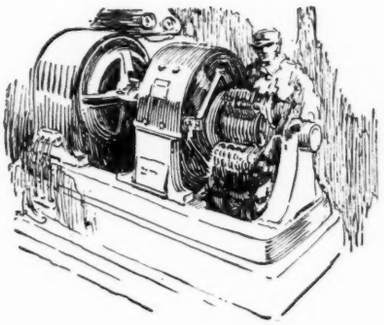
THE pernicious habit of regulating the draft by the ashpit door still persists in some plants where the relative effort of kicking a door and pulling a chain is all that determines the method of operation. Of course it is still easier to let a damper regulator perform this work, but such refinements are generally absent in plants of the type under discussion.

These delicately gaged kicks at the ashpit door would do less harm if directed at the human mechanisms that operate the plant. Wear on shoe leather is by no means the chief expense. With the uptake damper wide open and the combustion air throttled at the ashpit door, the needlessly augmented suction over the fire and throughout the upper portions of the setting draws in a flood of cold air through innumerable cracks and pores and past warped firedoors. Only an insignificant portion of this air plays any helpful part in combustion. The volume of hot gases wasted up the stack is greatly increased with a most serious effect on the coal bill.

It is particularly unfortunate that the plants that still cling to this antiquated method of controlling the draft are the very ones that allow the boiler settings to get in that state of disrepair where suction over the fire will do the most damage.

It was thought at one time that it was impossible to have too many valves in the power plant, particularly on steam and feed-water lines, it being considered good practice to provide for isolating any particular section of the line without interfering with the operation of the plant. But with the advent of higher pressures and superheat there appears to be a growing tendency toward the use of as few valves as possible.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for June will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during May for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to Andrew F. Sheehan, of Holyoke, Mass., for his article on "How Small Details Can Affect the Economy of the Power Plant," in the June 23 issue.

The second prize of $15 goes to Edwin C. Bliss, of Elia, Camaguey, Cuba, for his article on "Home-Made Ejector for Handling Bagasse Makes Big Saving in Labor," in the June 16 issue.

The judges were: (Chairman) Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City; Norman N. King, chief engineer, Singer Bldg., New York City, and D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City.

Utilizing the Waste Water in the Ice Plant

In our 30-ton ice plant we have been troubled with a shortage of condensing water, due to adding to the capacity of our plant.

The water is obtained from deep wells, and as we were in urgent need of more, we were forced to look for some quicker way of obtaining it than drilling another well, which would have been expensive and might have been a failure, as the wells we are now operating are not delivering as much water as they once did. The maximum supply from the wells is approximately 30 gal. per minute.

We were also in need of more condensers, as the head pressure was 225 lb., which of course meant less efficiency and an increased power bill. We had no cooling tower, so we decided on another plan that has been a success, as it has reduced the head pressure to between 175 and 200 lb. gage. We built a reservoir of about 200 gal. capacity, into which we discharged the water from the core pump and the ice dump instead of running it into the sewer. The dump is of the sprinkler type and the water, after running over the cans, is reduced in temperature from 10 to 20 deg., so this gave us additional cold water. The deep-well pumps leak some water at the stuffing boxes, so provision was made for catching this and draining it to the reservoir. In fact, we saved all the water, cold enough for condensing purposes, that had been going to waste.

We had an old belt-driven pump on hand, so this was rigged up over the reservoir and belted to a 1-hp. motor. By running the pump at a normal speed, we were able to get about 8 gal. of the cold water per minute through the condenser and that reduced the head pressure 25 to 40 lb. This supply can be increased still more by throwing the scrap ice from the storage rooms into the reservoir.

Undoubtedly, other plants have been utilizing the waste water in a similar way, but in all the plants that I have observed the core and dump water was thrown away, which is a big waste as the temperature of this water is in most cases much lower than the regular condensing water.

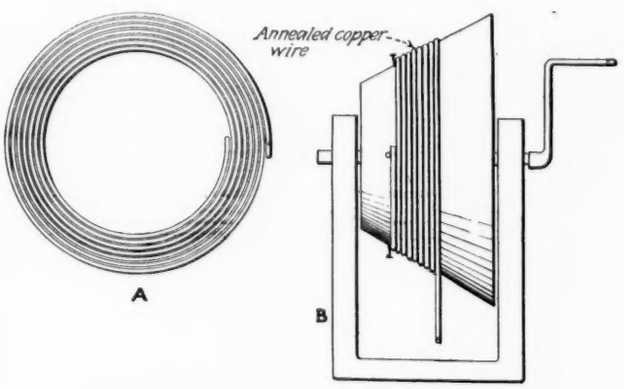
R. G. CASHWELL.

Lumberton, N. C.

Making Copper Wire Gaskets

For cylinder heads, valve cages, steam-chest covers, etc., a soft copper wire makes an ideal gasket and one that can be easily made to fit any size of cover or flange.

The wire should be soft, and this condition may be given it by heating it to a low red heat and plunging it in water to cool it quickly.



Method of forming gasket of copper wire

To make the gaskets, a cone frustum is turned from a wood block with the small diameter some smaller than the smallest gasket desired and with the large diameter some larger than the largest gasket desired. The face should be made about 45-deg. angle with the

base. The frustum is mounted on a rod as a shaft and fitted in a frame *B* that may be clamped in a vise or bolted to a post.

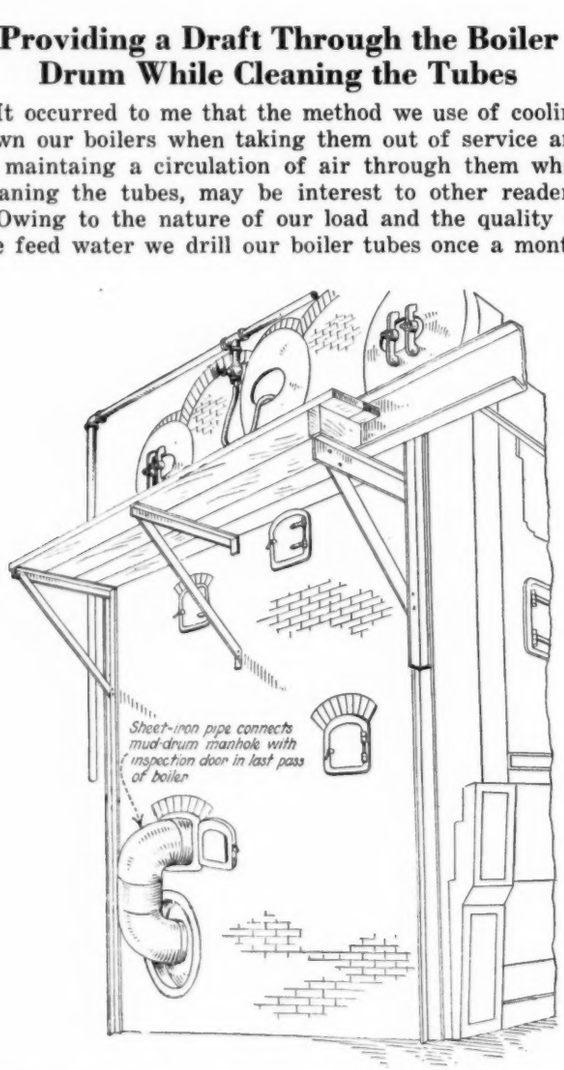
Nails are driven in the frustum at equal distances from the base and at positions where the diameter will equal the inside diameter of the gasket desired. The wire is then held tight while the crank is turned and the wire wound on the face of the cone. When the width of the coil equals the width of the gasket required, the wire is cut and allowed to expand, which will allow one coil to lie within the next larger, as shown at *A* in the illustration. The sides may be covered with shellac which, when compressed between the machine heads, will fill between the turns and make a practical copper gasket. G. G. McVICKER.

North Bend, Neb.

Providing a Draft Through the Boiler Drum While Cleaning the Tubes

It occurred to me that the method we use of cooling down our boilers when taking them out of service and of maintaing a circulation of air through them while cleaning the tubes, may be interest to other readers.

Owing to the nature of our load and the quality of the feed water we drill our boiler tubes once a month.



Draft through upper drum and tubes is obtained by connecting mud-drum manhole with last pass of boiler

A boiler is taken off the line at 5 p.m. and cooled down as soon as possible. Then about 11:30 p.m. the manhole covers on the steam and mud drums are removed and the drums washed with water under a pressure of 100 lb. In order to quicken the cooling of the drum and bank of tubes in which the drilling is to be done, we connect the manhole of the mud drum with the inspection door to the last pass, by means of a pipe made of No. 16 gage galvanized iron as shown in the illustration. Then by closing all drafts and firedoors and opening the damper in the breeching, a good circulation of air is obtained through the drum and tubes.

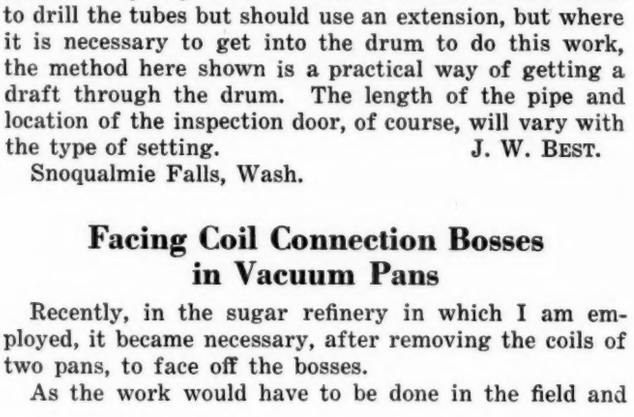
One end of the pipe is made to fit the mud-drum manhole and the other to fit inside the door frame. Some readers may say that one should not enter the drum to drill the tubes but should use an extension, but where it is necessary to get into the drum to do this work, the method here shown is a practical way of getting a draft through the drum. The length of the pipe and location of the inspection door, of course, will vary with the type of setting. J. W. BEST.

Snoqualmie Falls, Wash.

Facing Coil Connection Bosses in Vacuum Pans

Recently, in the sugar refinery in which I am employed, it became necessary, after removing the coils of two pans, to face off the bosses.

As the work would have to be done in the field and



Equipment used in refacing bosses on vacuum pans

time was pressing it was necessary that a method be found that would permit the work to be done quickly. Our cylinder portable boring-bar outfit was considered with a view to fitting it for the job, but the smallest bar of the set was too large. The method shown in the illustration was finally worked out.

Fig. 1 shows the type of pan and Fig. 2 how the improvised tool was set up for facing the bosses *C*, twenty-four in all. The boss *D* of one of the pans needed refacing, and to do this particular job a different way for holding the machine had to be devised, as illustrated in Fig. 3.

In order to bring the bar in line with the center line of boss *D* wedges were fitted at *G* and the flange *H* bolted by means of an eyebolt as shown. Additional bracing from the floor and ceiling was used to hold the machine rigid. The driving gear train of the portable boring bar was placed on the shaft *I* and a small electric motor used for driving. The entire job was completed within the estimated time for this feature of the plant repairs. H. D. ST. MARTIN.

Gramercy, La.

Comments from Readers

Leaky Air-Compressor Discharge Valves and High Temperatures

Referring to Mr. Richards' letter on page 704 of the May 5 issue, in which he argues against the theory advanced by F. C. Blomberg in the March 24 issue, as to a broken discharge valve in an air compressor causing the temperature of the air to increase, I should like to add that from my experience with air compressors I am inclined to agree with Mr. Blomberg.

Some time ago we had occasion to renew a cylinder-head gasket on our compressor on a Saturday afternoon, and after starting up for a few minutes' run to see that everything was in order, the machine in question was not started again until the following Monday morning. The valves had been removed and cleaned at the time of renewing the gasket and were apparently in good order. After running about two hours the cylinder had become hot enough to cause the film of oil on the outside of the cylinder, left by the wiping rags, to pass off in smoke. The cooling-water supply was immediately turned on full and the machine kept running until noon. During the noon hour we examined the valves and found a small piece of the head gasket lodged under one of the discharge valves.

Referring to Mr. Richards' article, he says: "As the pressure in the cylinder falls quickly at the beginning of the return stroke, the volume of compressed air escaping backward past the broken valve would be small, and the temperature of even this small portion would fall with its re-expansion." My experience, however, would not seem to bear this out, and if a small piece of gasket caused the increase in temperature on our compressor which is a 10x12-in. single-stage machine, it is reasonable to suppose that similar results could be expected from a broken discharge valve on a much larger machine.

Mr. Blomberg did not show the layout of his piping, but it seems to me that the carbon residue found in the receiver might have been due to oil leaking back through the air line from the oil-storage tank to the air receiver. The accumulation of carbon $\frac{1}{4}$ in. in thickness in the receiver, as mentioned by Mr. Blomberg, does not sound reasonable if a good quality of cylinder oil was used on the compressor.

Worcester, Mass. LEROY BLAKE.

Welding Patches on Boilers

I notice in the March 3 issue, a letter from H. T. Smith, in connection with his article in the Nov. 18, 1924, issue, on "Welding Patches on Boilers a Dangerous Practice." I was one of those who criticized Mr. Smith's original article, so I do not feel that it would be out of place for me to say a few words further in regard to the matter.

The original article by Mr. Smith referred to patches in mud-ring corners in locomotive boilers, while in the second one he refers to patches in the shell of the boiler. The two types of patches are fundamentally different, the former being largely in use and the latter not being used at all by anyone who desires to do safe work.

Mr. Smith's explanations of the difficulties from welded patches in boiler shells are quite correct. Welding in boiler shells is forbidden by all authorities with which I am acquainted. My comments on Mr. Smith's original letter had to do only with the mud-ring corner patches, which I know to be safe if properly applied. I doubt if he will find anyone disagreeing with him on the welding of patches in boiler shells.

I would point out further that the efficiency of a welded joint depends largely on the type of the joint and on the strength of the plate in which it is made, thorough fusion being assumed in all cases. If anyone is particularly interested in this subject, he would do well to read all the matter in the transactions of the A.S.M.E. for 1921, including the discussions. Further information is available in the following papers: "Strength of Electrically Welded Pressure Containers," by Prof. R. J. Roark, abstracted in *Mechanical Engineering* for April, 1922; "Tests on Welded Cylinders," by Professors Fessenden and Bradford, abstracted in *Mechanical Engineering* for September, 1922; "Fusion Welding," by S. W. Miller, read before the American Iron and Steel Institute, November, 1921; "Some Principles of the Construction of Unfired Pressure Vessels," by S. W. Miller, presented at the Spring meeting of the A.S.M.E. at Atlanta, Ga., 1922; Bulletin No. 5 of the American Welding Society.

From these papers it will be seen that the general statement that the efficiency of a welded joint is a definite figure is incorrect, because it depends upon conditions, in some cases being over 100 per cent.

With regard to Mr. Smith's statement that the weld metal is inherently harder, both Brinell and scleroscope tests show that there is practically no difference between the hardness of the weld metal and that of ordinary boiler plate, although it is true that a weld has less ductility than boiler plate. It is always desirable to use low-carbon, low-strength plate for welding, so that the strains may be absorbed in this ductile material.

I certainly do not agree with the boilermaker critic to whom Mr. Smith refers, and who seems to have felt that Mr. Smith had no business to write an article condemning welded patches. I believe that Mr. Smith is thoroughly right in his position that the operating engineer should always have before him the safety of the plant under his control. Any right-minded man in charge of an operation that is potentially dangerous should see that to the best of his ability conditions are as safe as possible, not only for his own sake, but for the sake of the public, and this is aside from any incidental property damage that might be the result of any failure. It is by such comments as Mr. Smith has made that the facts are brought out.

Long Island City, N. Y. S. W. MILLER.

Computing the Steam Consumption from the Temperature of the Return Water

In the June 9 issue, page 915, Andrew F. Sheehan gives a method of computing steam consumption from the temperature of the return water. He finds the exact answer by algebra, and for those not familiar with algebra he shows how to get the approximate answer by the trial-and-error method.

Some years ago I had occasion to work out a similar problem, and for the benefit of the engineers working with me who were not familiar with algebra, I deducted a simple rule from the equation

$$\frac{T^1X + T^2Y}{X + Y} = T^3 \text{ or } X = (X + Y)\frac{T^2 - T^3}{T^1 - T^3}$$

in which

X = Pounds of condensate;
Y = Pounds of makeup water;
T^1 = Temperature of condensate;
T^2 = Temperature of makeup water;
T^3 = Temperature of mixture.

Rule: From the temperature of the mixture subtract the temperature of the makeup water. Multiply this by the pounds of mixture and divide by the difference in temperature of condensate and makeup water to find pounds of condensate.

Applying this rule to Mr. Sheehan's problem and simplifying it by leaving out 32 deg., we have: Temperature of condensate, 209 deg. F.; temperature of mixture, 161 deg.; temperature of makeup water, 120 deg.; total weight of mixture, 17,000 lb.

$$\frac{(161 - 120)\ 17{,}000}{209 - 120} = 7{,}831 \text{ lb. of condensate.}$$

While this is a useful method in problems of mixtures, I prefer either a weighed condensate or steam-flow test. THOMAS HARKINS.

Hull, Quebec, Canada.

Cooling Medium for Turbine Oil Cooler

I note in the May 19 issue a communication from L. J. Levit, in which he states, "The main argument for the use of condensate in heat transfer apparatus is the thermal gain." It hardly seems possible that any engineer intrusted with the design of steam power stations is so slightly acquainted with the basic principles of their thermal balance as to install this type of apparatus for the sake of thermal gain.

The condensate from the main turbine has a certain heat capacity over the range between the temperature at which it leaves the condenser and the maximum temperature to which it can be heated by the particular heat reclamation system under consideration. The lower part of this range may be accomplished either through reclamation of the losses in generators, bearings, transformers and air ejectors or by extraction of additional steam from the low-pressure bleed point. It is true that a slight increase in heat reclamation is accomplished when heating is done by bled steam due to the slight increase in the quantity of condensate, but it can be shown that this increase will not offset the additional cost of maintenance and cleaning of the heat exchanging apparatus, additional pumps and so forth when raw water is used. The only valid reason for using condensate in this class of apparatus is to have clean water in the heat exchanging equipment.

Many waters contain forms of algæ which will almost fill up the tubes of cooling equipment in a short time, necessitating cleaning, not on account of poor heat transfer, but because of decided restriction of water flow. This is not only an inconvenient condition but also a dangerous one. In a properly designed system for using condensate in the cooling apparatus, the complication is less than in a system using raw water. With a condensate system the hotwell pumps serve to force the water through the apparatus while with a raw-water system separate pumps must, or at least should, be provided for this purpose.

Under the usual conditions of installation the water pressure is higher than the oil pressure and any leakage occurring would be of water into the oil. Such an occurrence is serious and should of course be carefully guarded against. WALTER P. GAVIT.

New York City.

Shall He Take a Chance?

The foreword in the April 14 issue, entitled, "Shall He Take a Chance," describes a situation that is not uncommon, at least in some of its particulars. It describes my situation so well that I cannot let it go by without making a few remarks.

At no time have I ever become dissatisfied with my job, but I have been thoroughly disgusted with myself, knowing that a job is only the medium that makes you a man or a manikin. Although I have not attended any technical school and have no degree, I have been a reader, observer and a student and have completed three courses of study with correspondence schools.

For a number of years I have held a position that has called for a certain amount of responsibility. During this time my employer has allowed me to install all the equipment that has been purchased for our mines, and I feel that I have made a success of it, which has given me confidence, and I now want a broader position than that of watch engineer. If the opportunity was given me to hold a more responsible position, I would be willing to learn more to earn more. I have now reached the point to be answered, Shall I take a chance?

Before taking the chance, however, I must look at my environments from every angle. As I have already mentioned, I am not dissatisfied with my job nor with my employer. There is an old saying, that you may be a subordinate, but if the management can leave you with some responsibility, you will not remain a subordinate long. Every opportunity has been given me. There has been nothing done to hold me back. I have reached the top rung in my position. In order to go higher I must give up my position, cutting loose from my old payroll to look up a new one.

I will not attempt to tell why I am not willing to take a chance. I have now reached the age where I can claim thirty years of service under the same superintendent and good will with my company. This I can never get again with another. My resolution now is to stick.

To the man at the age of thirty who has made good and feels that his company has no more opportunities for advancement, I offer the following suggestion. Go to your employer in a manly way and tell him what your plans are, if he thinks it will be to your advantage to make a change, he will advise you to take the chance. Then look the part and make good.

Norway, Mich. THOMAS PASCOE.

Piping Steam to Pump Receiver Corrects Trouble

With reference to the article by M. J. Murphy in the April 28 issue on "Piping Steam to Pump Receiver Corrects Trouble," all that is required in a connection of this kind is a vent pipe from the receiver tank back to any point in the heating system above the desired water level. This will relieve steam and air from the receiver and prevent it becoming steam bound or air-bound, thus balancing the pressures in the entire heating system. This would also permit the condensate to drain to the lowest point in the return mains and build up to the desired water level in the receiver.

In my opinion a direct-return steam trap is better than a pumping unit for this service, provided there is sufficient headroom above the boiler. Under the present system high-pressure steam must be utilized to pump the water back to the boiler, whereas with a direct-return steam trap the condensate can be made to drain through the return mains running close to the ceiling, back to a trap that will discharge it directly to the boiler under its own hydrostatic head and with better economy than with a pumping unit. T. J. SCHREIBER.

Baltimore, Md.

Stoker Operation in the Industrial Plant

The article on "Stoker Operation in the Industrial Plant," in the May 19 issue, contains some statements which, I think, should be revised or at least supplemented, if they are to withstand more than a casual inspection.

I can see no reason why a combustion expert should be puzzled over the fact that "almost every stoker-fired plant has a method of operation all its own." The reason for this should be evident to the man who thoroughly understands combustion.

Let us see how the method of stoker operation described in the article will work out. We will assume the coal we are using to be of constant quality, the steam demand to be without variation and the feed-water supply to be constant, both as to quantity and temperature.

The quality of our coal being constant, it will require equal amounts of air at all times to produce the same percentage of CO_2, where the thoroughness of the mixing of the air with the combustible of the coal remains unchanged. Under these conditions the ashpit pressure required to maintain 0.5 in. at the damper should be a reliable indication of the fuel-bed condition so long as the pressure drop through the boiler is not changed by an accumulation of soot or other causes.

If we will now assume an increase of 10 per cent in the demand for steam, accompanied by a corresponding increase in the rate of supplying the feed water, the coal quality, feed-water temperature, and the desired percentage of CO_2 remaining the same as before, we will be required to increase the coal feed and the air supply in the same proportion as the increase in the steam demand.

Can this be done in accordance with the method outlined in the article referred to? To make it possible for the increased amount of air to flow through the fire, setting and boiler, it will be necessary either to increase the draft pressure tending to force the air through the unit or reduce the resistance to its flow. Under the conditions being considered, the only chance to reduce the resistance is by slowing down the stoker so the fire thickness will decrease. With the thinner fire it will be necessary to reduce the ashpit pressure to maintain 0.5 in. draft at the back damper without changing the setting of this damper.

In the effort to obtain the increased air supply required by the increased steam demand, a decrease is made in the coal feed where an increase is necessary, and a decrease in the ashpit pressure where there should have been an increase. We must therefore come to the conclusion that it is impossible to maintain a balanced draft at the damper while meeting a varying steam demand, by changing only the coal feed and the ashpit pressure. K. R. DUNCAN.

Owatonna, Minn.

Measuring Coal on Traveling-Grate Stokers

In the June 16 issue I noticed the letter by E. Ogur, commenting on the article by J. R. Darnell in the April 21 issue entitled, "Measuring Coal on Traveling-Grate Stokers."

This, no doubt, represents another man's thought on this subject, but I do not agree with him. He says that if records are not exact, it is a waste of time to use them. We all know, of course, that no records are exact. The late Alfred Cotton, who was consulting engineer for the Heine Boiler Co., presented a paper before the A. S. M. E. several years ago, in which he showed that even an evaporation test on a boiler, when conducted in accordance with the A. S. M. E. specifications, was subject to a considerable error. Therefore, I believe it is reasonable to say that records, even though they are not exact, are much more useful than no records whatever. For instance, a steam-flow meter on the output of a boiler, even if it had a possible error of a small percentage, would in most cases be much closer than the engineer at the plant could guess.

Many steam-flow meters have been placed on boilers which were doing practically nothing, and in this case just a pure indicating device of doubtful accuracy would be all that is needed to determine that something is radically wrong.

In regard to measuring coal fed to a boiler by means of determining the volume of coal passing under the gate on a chain-grate stoker, I wish to say that I believe that in most cases this is as accurate a method as actual weighing. There are power plants all over the country with weighing devices, where the percentage of moisture in the coal is entirely overlooked. The fireman carefully weighs out a charge of coal and then feeds it to the boiler, not knowing whether it is fairly dry or high in moisture content. In some places where they actually do sample the coal and run a laboratory moisture check, it is often run by an inexperienced man who merely makes a rough determination of moisture. This, coupled with the uncertainty in getting a representative sample, makes weighing of coal anything but ideal. On the other hand, a volume device gives readings independent of moisture, and although the device is practically a revolution counter, a well-conducted calibration test will determine a multiplier for it, which will make it give consistent results.

Philadelphia, Pa. J. W. HOGG.

Power-Plant Instruments

The article, "Power-Plant Instruments," by R. S. Reed, in the May 19 issue, covers thoroughly the two questions of where instruments are desirable about the power plant and what types are most suitable for each purpose. Particularly timely is his warning against the installation of non-essential instruments, the records from which are either of little use or actually confusing when analyzing plant performance. A third factor, maintenance, just as vital as the two covered by Mr. Reed in his article, is frequently overlooked by the designer when providing control instruments. Two things are well known to engineers: First, unreliable data are worse than no data; second, no instrument or machine retains its original calibration indefinitely. And yet, while no engineer would permit the erection of a new engine without indicator cocks, many expensive, delicate instruments are installed with no provision for checking and correction. Such instruments soon develop misleading inaccuracies and are often allowed to fall into disuse because of known unreliability. Common causes for loss of original calibration are wear of moving parts, "set" due to continued exposure to high temperature or pressure and abuse of ordinary service. Means for periodically checking the readings of all instruments must be provided if reliable readings are to be continuously assured, and while suitable connections may be conveniently and cheaply provided at the time of erection of the apparatus, the failure to provide them at this time means an awkward makeshift job later, often requiring the shutdown of important apparatus at considerable expense.

The following list of auxiliary or test connections covers the main types of instruments used in power-plant work: For pressure, vacuum and draft gages a tee should be provided in the pipe connection just ahead of the instrument. From this tee a short nipple and valve or cock should be run out, providing a ready means for connecting the test gage, mercury column or draft gage in parallel to the service instrument. A gate valve is usually preferred at this point to reduce the possibility of leakage and to facilitate the blowing out of the gage line.

For checking thermometers a second well should be installed close to the well or bulb of the service thermometer and should be placed along the line of flow of the fluid to assure equal temperatures at the two wells. Whenever possible the well should be placed with the mouth above the horizontal so that mercury or oil may be used to insure good heat transmission between the well and the glass test thermometer. In the case of pyrometers it is usual to provide only for recalibration of the indicator or recorder by use of a test millivolt meter or standard cell, though it may be desirable to provide for the insertion of a second thermocouple should the condition of the service thermocouple come into question.

Flow meters are usually provided with means for checking the calibration by zero setting of the mercury level or by application of a static water head corresponding to the differential produced by a given flow. However, in piping up a flow meter it is well to provide tees and valves in the lead and trail lines for blowing down these lines as well as for the possible use of a manometer if particularly accurate tests are to be run.

Gas analysis machines, being especially sensitive to misadjustment, should invariably be provided with tee connections in the sample lines so that checking with the hand Orsat may easily be done.

In the case of tachometers and revolution counters the only thing necessary is to provide either an exposed and centerpunched shaft end or a machined length of shaft, the former being preferable. An ordinary hand revolution counter and a watch serve admirably for accurate checking of speeds. Where a shaft end is not accessible, a rubber-tired wheel is mounted on the hand counter and rolled on the shaft. With this arrangement the shaft and wheel diameter ratio must be used to reduce counter reading to shaft revolutions per minute.

With the simple provisions cited carefully carried out at the time of erection, it is an easy and inexpensive matter to schedule and maintain a periodic inspection and check of all instruments, both indicating and recording. Reliable readings are of inestimable value; the truthful indicator shows the operator conditions at any moment, the truthful recorder tells the management of conditions over any period. E. C. RAMAGE, JR.

Pittsburgh, Pa.

Checking Synchroscope Connections

In the issue of June 23 N. L. Rea gives details for putting alternating-current generators into service. On page 983, under the headings "Checking Phase Rotation and Phasing Out with Transformers and Lamps," certain operations should be elaborated upon and more fully explained in order to give a clearer understanding of the operations involved and the procedure to be followed to assure that the correct result will be obtained. Assuming that the phase rotation has been checked and found OK, then it becomes necessary to check the correctness of the connections of the synchoscope. To accomplish this and be sure of absolute correctness, the following method may be used:

When the phase rotation of the generator has been definitely checked with its bus or the circuit with which it is paralleled, disconnect and insulate the leads from the generator to the switch at the machine. The machine's synchroscope connections are of course connected to the leads between the switch and machine. The machine switch may now be closed and there will then be potential on the leads, between the switch and the machine, exactly under the same conditions as when the machine is in operation and in phase with the busbar voltage.

The synchroscope or synchronizing lamps will now indicate the conditions as they will exist in actual operation. If lamps are used, they will be either bright or dark and the lamp connections may be changed to give the condition desired. In the United States it is usual practice to have the lamps dark when the machines are in phase, while in Canada one often finds synchronizing done with lamps bright. If a synchroscope is used, the pointer will come to rest either at the top or the bottom of the dial. Since the top is the correct position with the usual type of instrument, the pointer may be brought to the top position by interchanging the synchroscope leads to the incoming machine.

The foregoing details describe methods that eliminate the necessity of checking potential transformer polarities and also overcome the chance of wrong markings of the terminals, since the tests approximate the actual conditions as they will exist in operation.

Springdale, Pa. C. OTTO VON DANNENBERG.

Questions and Answers

Conducted by

Franklin Van Winkle

Star-Delta Connected Transformers

We have three 100-kva. single-phase transformers connected star-delta on a 4,400- to 550-volt three-phase 60-cycle circuit. In case of one transformer burning out, can the other two be connected so as to operate on the circuit? *J. W. K.*

Transformers connected star-delta on a three-phase circuit for changing from 4,400 to 550 volts, cannot be connected open-delta, and two transformers used in case one of the three in the star-delta connection burned out. The individual transformers are designed for stepping down from 2,500 to 550 volts. Connecting them in star on the high-voltage side makes them good for 4,400 volts. If two of the transformers are connected open delta, they would then be good for only 2,500 volts and not 4,400, which is the line voltage.

Importance of Boiler Circulation

What advantages are to be gained from active circulation in a boiler? *W. L.*

Water absorbs heat only slowly by conduction. Convection by movement of currents is necessary to obtain rapid heat absorption. It has been demonstrated that the B.t.u. absorbed per minute by circulation of water, per square foot of tube surface, is approximately doubled when the circulation increases to eight times its original velocity. Any portion of a boiler in which there is poor circulation is inefficient steam generating space. Circulation is important also for disengagement of steam. As soon as steam bubbles are formed, they should be swept from the heating surfaces. When the bubbles remain adhering to the hot plates, the heat of the fire is not promptly transmitted and there is overheating of the boiler material. This is a common cause for burning of vertical tubes, water legs and furnace sheets. Another important office performed by circulation is keeping the sediment of the boiler water in motion, thus preventing solid matter from settling and forming a scale.

Vacuum Chamber

What is the vacuum chamber which is used on a pump suction line? *R. L. D.*

When an air chamber is attached to the suction side of a pump to steady the flow, it is frequently called a "vacuum chamber," but more properly is designated a suction air chamber. Properly speaking, there is no such thing as a vacuum chamber on a pump. The use of a suction air chamber is the reverse of that of the air chamber placed in the discharge side of the pump. The flow of water into a pump is due to atmospheric pressure alone or combined with pressure due to the suction head, and once the flow is started, for best results it must be continuous.

The effect of the suction air chamber is to take away from the suction chamber of the pump, the water hammer and disturbances resulting from continuous flow into the pump suction chamber from which the discharge is intermittent. The ordinary air chamber in the discharge side of the pump changes the intermittent flow into a continuous one, whereas the suction air chamber has for its object the conversion of a continuous flow into an intermittent one. Just as in the discharge-pipe air chamber, air in the suction-pipe air chamber acts like an elastic cushion which noiselessly receives the excess of flow and gives it out again. The air is thus alternately expanded and compressed at each wave or impulse of water flowing into the pump chamber.

Turbine Efficiency Reduced at Light Load

Why is a steam turbine less efficient at light load? *W. L. T.*

Efficiency depends largely on the speed or velocity given to steam which is projected into a row of moving blades. For single-row impulse wheels, the velocity should be about twice the vane speed (usually slightly faster). It should enter two-row multi-velocity stage buckets at about four times vane speed and a row of reaction vanes a little faster than actual vane speed. If the same number of nozzles are used at light loads as at full load, throttling must be resorted to for steam regulation. There is an energy loss when thus throttled since a pound of steam delivered at a lower pressure will give up less energy in expanding to exhaust pressure. At light load the smaller range of steam pressure through a single- or multi-stage turbine tends to produce less velocity for steam passing through the first-stage nozzles, and in multi-stage units this velocity reduction is relatively greater nearer the exhaust region. Steam speeds are therefore too slow for best efficiency near the throttle end of the turbine and in multi-stage machines relatively slower at the exhaust. If light loads are carried by cutting out individual nozzle groups instead of by throttling, so that full pressure is received at the throats of such nozzles as are in operation, there is no energy loss due to throttling.

Measuring Angle of Advance of Eccentric

How can it be determined what number of degrees the eccentric of a single-eccentric Corliss engine is set more than 90 deg. ahead of the crank? *B. H.*

As in ordinary valve setting, first see that the eccentric rod is adjusted to such length that the rocker arm swings an equal distance each side of a plumb line, and have the reach rod of such length that the central mark on the wristplate hub swings an equal distance to each side of the central mark on the wristplate stud. Then when the engine is turned over until the central mark on the wristplate hub comes opposite to the central

mark on the hub, the radius of the eccentric will be 90 deg. with the line of the stroke.

Now place the crosshead at about ⅞ of the stroke, make a mark on the crosshead to agree with a mark made on one of the guides, and bring a stationary pointer up to the face of the wheel near the corner of the face. Turn the engine over past the dead center until the mark on the crosshead is again opposite to the mark on the guide; make another mark on the wheel opposite to the stationary pointer and, with a pair of dividers, locate a mark midway between these marks. When the engine is turned to bring this middle mark opposite to the stationary pointer, the crank will be on dead center. Now turn the engine over until the wristplate is opposite to the central mark on the wristplate hub, and make a mark on the wheel opposite to the stationary pointer.

With a pair of dividers or a strip of paper, transfer to a scale or rule the distance between this last mark and the true dead center mark and, with a tape line, measure the circumference of the wheel at that part of the face where the marks were made. Then, with all dimensions reduced to inches, the number of degrees the eccentric is more than 90 deg. ahead of the crank will be the short distance measured on the wheel multiplied by 360 and divided by the measured circumference of the wheel.

Degree of Vacuum Not Shown by Temperature

Why cannot the number of inches of vacuum, or the absolute pressure of a condenser, be known from the pressure corresponding to the temperature of dry saturated steam as given in the steam tables? *B. L. N.*

The temperature is not an index of the pressure on account of the presence of "air" or other incondensible gases which must be removed by the air pump. The exhaust of a condensing engine consists of water, vapor and gases, the gases being a mixture of those originally dissolved in the boiler-feed water and atmospheric air which leaks into those parts of the condensing system in which a partial vacuum is maintained. Hence the absolute pressure that would be indicated by a vacuum gage is that of water vapor at the pressure corresponding to the temperature plus the pressure due to incondensible gases, and the pressure always is higher than the pressure of dry saturated steam which corresponds with the temperature.

Safe Working Pressure for Boiler Shell

What would be the maximum allowable working pressure, with factor of safety of 5, for the shell of a boiler 72 in. in diameter where the tensile strength of plate is 55,000 lb., thickness of plate ½ in., with longitudinal seams butt and double-strap joints, double riveted, thickness of butt straps ⅜ in., pitch of rivets in the outer row, 5½ in., and the diameter of rivet holes 1 in. with rivets driven to fill holes? *R. A.*

The efficiency of the longitudinal joint would be the least strength of a unit of pitch P indicated in the figure, divided by the strength of an equal length of the solid plate.

(1) The strength of ½-in. solid plate per unit of pitch $P = 5\frac{1}{2}$ in. would be

$$5.5 \times 0.5 \times 55{,}000 = 151{,}250\ lb.$$

Having the thickness of butt straps ⅜ = 0.4375 in., diameter of rivets 1 in. with cross-sectional area = 0.7854 sq.in., and allowing strength of a rivet in single shear = 44,000 lb. per sq.in. of cross-section and strength in double shear = 88,000 lb., and crushing strength of material 95,000 lb. per sq.in.; then the strength of the joint per unit of pitch P would depend on the least value obtained from the following considerations:

(2) Strength of plate between rivet holes in the outer row =

$$(5.5 - 1) \times 0.5 \times 55{,}000 = 123{,}750\ lb.$$

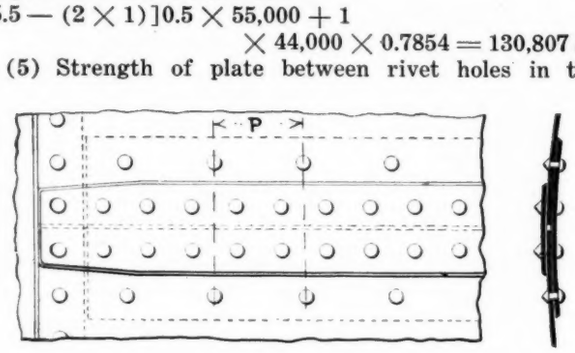
(3) Shearing strength of two rivets in double shear, plus the shearing strength of one rivet in single shear =

$$2 \times 88{,}000 \times 0.7854 + 1 \times 44{,}000 \times 0.7854 = 172{,}788\ lb.$$

(4) Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row =

$$[5.5 - (2 \times 1)]0.5 \times 55{,}000 + 1 \times 44{,}000 \times 0.7854 = 130{,}807\ lb.$$

(5) Strength of plate between rivet holes in the



Butt and double strap joint double riveted

second row, plus the crushing strength of butt strap in front of one rivet in the outer row =

$$[5.5 - (2 \times 1)]0.5 \times 55{,}000 + 1 \times 0.4375 \times 95{,}000 = 137{,}812\ lb.$$

(6) Crushing strength of plate in front of two rivets, plus the crushing strength of butt strap in front of one rivet =

$$2 \times 1 \times 0.5 \times 95{,}000 + 1 \times 1 \times 0.4375 \times 95{,}000 = 136{,}562\ lb.$$

(7) Crushing strength of plate in front of two rivets, plus the shearing strength of one rivet in single shear =

$$2 \times 1 \times 0.5 \times 95{,}000 + 1 \times 44{,}000 \times 0.7854 = 129{,}557\ lb.$$

The least strength is obtained from consideration (2), namely, 123,750 lb., and the efficiency of the joint would be 123,750 ÷ 151,250 = 0.818, or 81.8 per cent.

The maximum allowable working pressure, for the shell, obtained by the formula, $\frac{TS \times t \times E}{R \times FS}$ = lb. per sq.in., where

TS = Ultimate tensile strength of shell plates = 55,000 lb.

t = Minimum thickness of shell plates in weakest course = 0.5 in.

E = Efficiency of longitudinal joint = 0.818.

R = Inside radius of weakest course of the shell = 72 ÷ 2 = 36 in.

FS = Factor of safety = 5,

would be, $\frac{55{,}000 \times 0.5 \times 0.818}{36 \times 5} = 124.9$, or practically 125 lb. per sq.in.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Temperatures Determined in Reinforced-Concrete Chimney Shell*

By E. A. Dockstader
Stone & Webster, Inc.

CRACKS that have appeared in a number of concrete chimneys have led to some doubt on the part of engineers as to whether such construction is reliable. Ordinarily, they may be traced to improper design or faulty workmanship.

Stresses in chimney shells due to temperature, however, are of great importance, but no data concerning them have been heretofore available. In order to assist in clearing up this point, provision was made during the construction of such a chimney for temperature tests.

The chimney that is indicated in Fig. 2 extends 188 ft. above its foundation on the steel framing over the boilers. It is 15 ft. internal diameter at the top and 20 ft. 10 in. external diameter at the bottom. The top extends 231 ft. 2 in. above the boiler grate, the grate being approximately 24 ft. above the ground.

The chimney was served by three water-tube boilers, operating at 250 per cent rating. During the test only two of these boilers were installed, the flue gases entering on opposite sides of the chimney.

The chimney was lined with common brick to a point approximately two feet below level *B* indicated in the Fig. 2. This lining was 8 in. thick.

During construction sleeves of brass about 2¼-in. inside diameter were cast in the chimney shell at various levels. The temperature was measured at the center of the chimney and the gas midway between chimney and shell and at several other points inside of and outside of the shell.

The average temperature of the gases at the boiler uptakes was 475 deg. F. and the computed mean velocity of the gases, 775 ft. per min. Readings taken in the afternoon showed higher gas temperatures and lower external concrete shell temperatures.

In Fig. 1 are plotted three sets of temperature readings taken during afternoons, the heavy dots indicating the positions of the various thermocouples with respect to the stack. The points at the right, for instance, showed the temperature of the concrete nearest the outside of the chimney shell. It was possible that the shift in the rays of the afternoon sun may have lowered the concrete temperature at this point to some extent.

In Fig 3 are plotted the probable temperature gradients in the concrete shell.

The readings perhaps do not give the maximum condition of temperature difference in the concrete which may occur on a very cold winter day, when the boilers are first put on the line after being banked over a low station-load period. The hot gases impinging suddenly on the inner surfaces of the concrete may raise its temperature rapidly, the outer surfaces becoming warm gradually as the heat flows through the concrete.

This investigation showed as might have been expected, that in general as the chimney shell becomes thinner, the actual temperatures in the concrete near the outside face become greater. However, the difference in temperature between the inner and outer surfaces of the chimney shell tend to become less.

The general trend of the test data warranted the conclusion that the maximum drop in temperature through the concrete of the chimney shell may be taken as: (a) 20 deg. F. per inch of shell thickness where the chimney is unlined. (b) 10 deg. F. per inch of shell thickness where the chimney is lined so as to furnish insulation equivalent to that of the lining in the chimney tested.

It is hoped that these tests will lead to further trials along the same line, and will result eventually in an accumulation of data from which still more positive conclusions can be drawn.

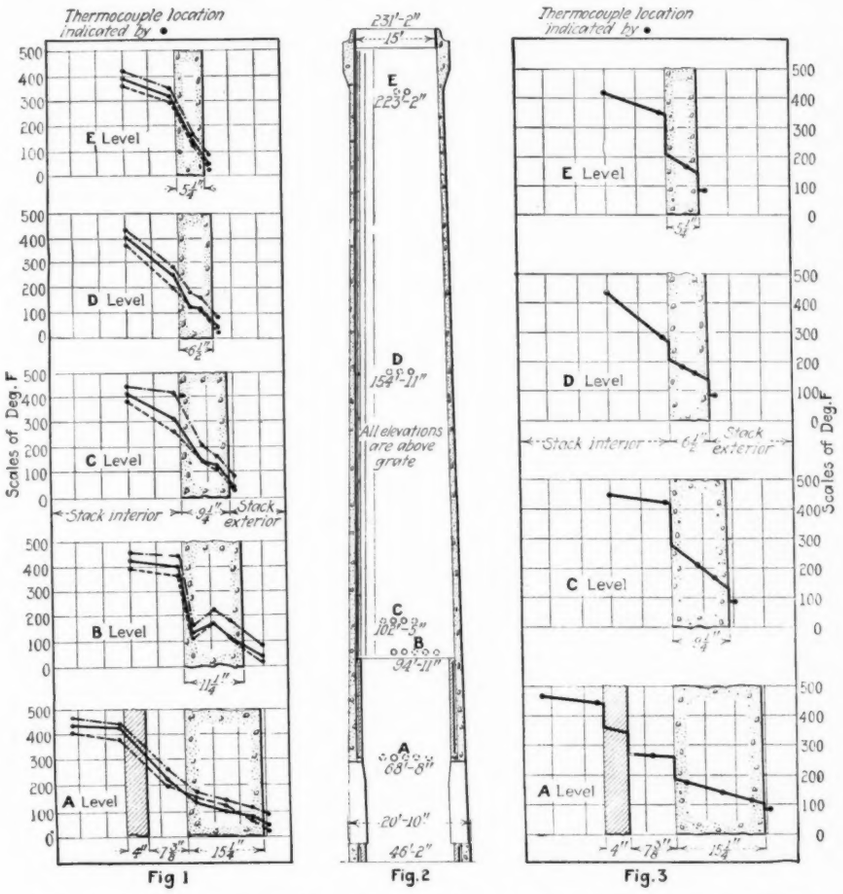


Fig 1 Fig. 2 Fig. 3

Fig. 1—Temperature readings plotted. Fig. 2—Locations of thermocouples. Fig. 3—Probable temperature gradients

*Abstract of paper, "Tests Made to Determine the Temperatures in Reinforced-Concrete Chimney Shells," presented before the American Concrete Institute at Chicago.

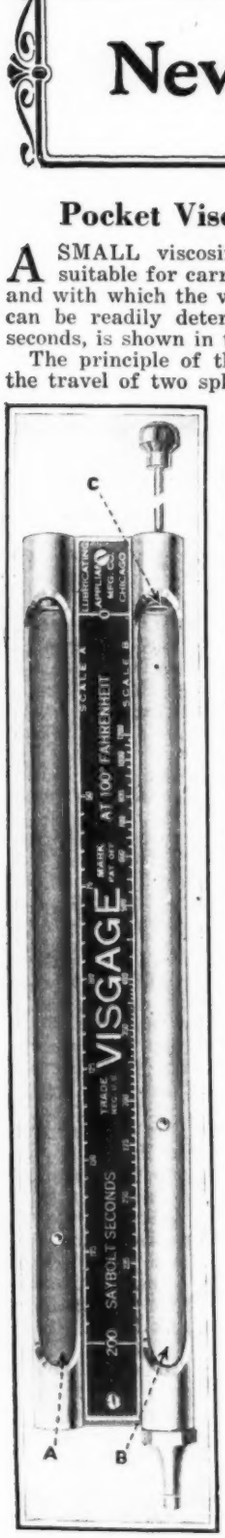
Calaveras County, Calif., Project.—J. W. Preston, Jr., has applied for a preliminary permit for an installation in the Middle and South Forks of Mokelumne River and the North Fork of Calaveras River, in Calaveras County, Calif. The scheme of development provides for the diversion of the headwaters of the South Fork of the Mokelumne into McCarty Reservoir on the North Fork of the Calaveras, with a conduit about five miles in length leading to a power house on the stream; a diversion dam on the South Fork of the Mokelumne, two miles above its mouth, with a conduit leading to a power house on the Mokelumne, three miles below the mouth of the North Fork; a diversion dam on the North Fork of the Calaveras River with a conduit leading to the Mokelumne River power house; and a reservoir on the Middle Fork of the Mokelumne formed by a dam above the mouth of Bear Creek, with a conduit leading to a power house on the South Fork, north of Railroad Flat. An alternative scheme provides for a reservoir on the South Fork of the Mokelumne River, near Railroad Flat, and the omission of the diversion from the South Fork and of the McCarty Reservoir and its power house, conduit, etc. The types of the proposed structures and the capacities of the installation have not been determined. The power is to be used for irrigation and in general sale.

New and Improved Equipment

Pocket Viscosimeter

A SMALL viscosimeter, "Visgage," suitable for carrying in the pocket and with which the viscosity of any oil can be readily determined in Saybolt seconds, is shown in the illustration.

The principle of the visgage is that the travel of two spheres through two oils is dependent upon their relative viscosities and that with two inclined tubes of the same diameter containing the same oil and at the same temperature, two small spheres of equal diameter will reach the bottom of the incline at the same moment. Also, if the viscosity of the oil in one tube is known, it is possible to develop a scale by which the viscosity of an unknown oil can be read direct.



View of Visgage

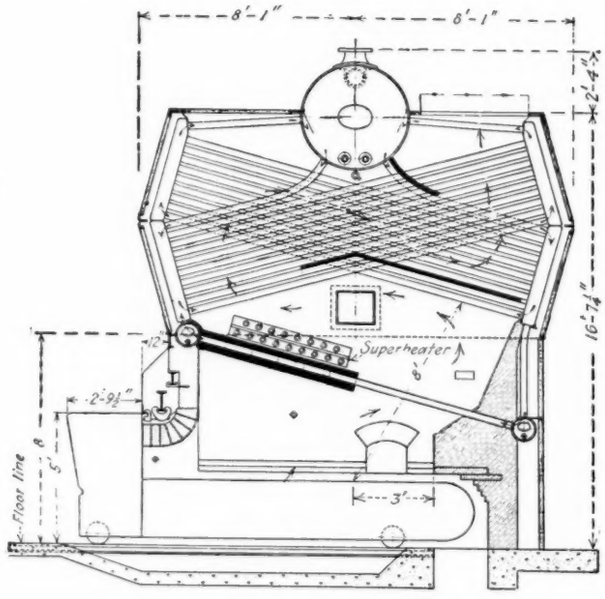
Referring to the illustration, two glass tubes are mounted in a metal case with a scale placed between them, each tube containing a small sphere of equal diameter. The tube *A* is filled with an oil of known viscosity, while the tube *B* is fitted with a plunger *C* for drawing the tube full of the oil on which the viscosity is to be determined. When the tube *B* is full, the instrument is inverted and the spheres allowed to reach the zero point on the scale. Then it is brought to an inclined position and the spheres permitted to move to the bottom. As one sphere reaches the bottom or the 200 line, the position of the other sphere, as shown by the graduation on the scale, gives the viscosity in Saybolt seconds of the oil in the tube *B*.

The operation takes less than a minute for a medium oil and no stop watch, thermometer or conversion tables are required, it being necessary only to have the oil at room temperature, so that the oil to be tested will be approximately the same temperature as the oil in tube *A*. When a test has been completed, the plunger in the tube *B* is returned to its original position, whereupon the oil is discharged and the tube cleaned ready for a new charge.

The instrument is manufactured by the Lubricating Appliance Manufacturing Co., Chicago, Ill.

Page T. H. B. Cross-Tube Boiler

To the single-drum cross-tube boiler made by the Page Water Tube Boilers Co., of Chicago, some innovations have been made by T. H. Burton, associated with this company, to attain smokeless operation and improve the economy by lowering the uptake temperature. The illustration will recall the general design. It will be noticed that the rear mud drum has been lowered and on the inclined tubes connecting it with the front mud drum, C-tile have been placed to form an arch over the grates to improve ignition. Above these tile is the new location for the superheater. Changing the baffling to make three passes instead of a single pass for the gases has resulted in lowering the uptake temperature about 100 deg. F. Owing to the contraction of the gases between the arch and the bridge wall and the right-angle turn caused by the baffle over the second row of tubes, thorough mixing of the products of combustion is obtained and the result is smokeless operation. The low headroom for this type of boiler has been retained after allowing 8 ft. from the grates to the tubes.



Arrangement of arch and baffles

Suprafrax Mix as Bonding and Coating Material

Suprafrax brick, made for some time by the Laclede-Christy Clay Products Co., of St. Louis, have been followed by the development of a Suprafrax mix, a bonding and coating material of highly refractory qualities. It has been developed primarily for the laying up of Suprafrax refractories, but is used also as a wash or coating for firebrick work of any kind. It serves not only as a protective coating for new brickwork, but for renewing and building up old settings as well.

It has been established that spalling is a function of vitrification. Under continued high heats firebrick tend to vitrify, becoming dense and glasslike in their structure, so that the tendency to crack under temperature changes is increased. The coating is said to reduce this tendency.

This material is supplied in the dry, ground form and is made ready for use by mixing with water to the proper consistency. It may be applied by trowel, brush, gun or sprayer.

Lehnco Boiler Control

The "Lehnco" boiler control, recently brought out by Charles J. Lehn, Oak Park, Ill., consists of steam-pressure and uptake thermostatic regulation controlling the speed of the stoker, the position of the damper and, if the installation uses forced draft, the amount of air supplied to the furnace. The regulator also may be applied to hand-fired and oil-burning installations. The operating medium is compressed air functioning through motor diaphragms interconnected by small tubing with the regulator of the system.

It is arranged to control boilers individually and in groups, bringing the several units up or down together or in successive order. A thermostatic control at the uptake holds flue-gas temperatures above a predetermined point, so that any one boiler cannot be operated at an inefficiently low rate, and to prevent blowing off, owing to a sudden drop in load, a master valve takes charge of the situation until conditions are readjusted, when the regulator again assumes control.

Reference to Figs. 1 and 2 will show that the main regulator is a diaphragm with steam pressure from the header on one side balanced by a mercury column on the opposite side. To prevent deterioration, water is in immediate contact with the rubber diaphragm on either side.

From the flanges of the diaphragm bolts support a crossbar carrying the terminals of air-pipe lines running to the individual boilers, three in the case illustrated, with a fourth line communicating with the master valve *A*. Above these terminals, or leak ports as they are called, a second crossbar secured rigidly to the stem rising from the diaphragm, carries valves to mate the ports. These valves are simply short bars square in cross-section at the bottom and threaded at the top, which slide freely up and down through openings in the cross member. Nuts at the top provide for adjustment as to height. When the boilers are to operate in unison, these valves are set at the same height and at graduated heights for control in sequence.

Following the pipe line to the boiler, Fig. 1, it may be seen that the stoker speed is controlled by a motor diaphragm linked to the pivot pin of the eccentric rod driving the stoker. As the air pressure builds up on the diaphragm, the pin is pushed outward in the slot against the action of a spring in tension, thus slowing up the stoker speed. A screw adjustment on the diaphragm lever limits the range of control. A second motor diaphragm is linked to the damper of the individual boiler and in accordance with the air pressure controls its position against the action of a counterweight.

A third element having operating connection with the stoker and damper control and inserted to prevent any one boiler from taking more or less load than its share, is the thermostat in the uptake, which limits the flue-gas temperature to a predetermined range subject to the position of the main regulator. The idea back of its use is to make each boiler burn a given amount of coal and to maintain the burning rate on each as uniform as possible. The thermostat is made up of two elements, one sensitive and the other non-sensitive, so that with an increase in temperature the sensitive element expands and closes an air port. The air pressure builds up and through the motor diaphragms slows down the stoker and moves the damper toward the closing position. When the fire has been checked, the thermostat will relieve the air line, opening the damper and increasing the stoker feed.

So long as there is an increasing demand for steam and the leak ports at the regulator are open, the thermostat cannot function, as the air leaks out of the system as fast as it enters. This is important, as otherwise the thermostat would interfere with peak operation.

Air at 10 to 15 lb. or at whatever pressure is required in any specific case, is admitted into the piping system serving each furnace through adjustable needle valves at points *B* and *C*. When the steam pressure is at normal and the leak ports of the regulator open, the air escapes to atmosphere through the ports. As soon as the steam pressure begins to build up, however, the excess pressure pushes down the regulator diaphragm, causing the valves to seat on the leak ports simultaneously or one after the other, as previously outlined. This allows the air pressure to build up in the line to each boiler sufficiently to operate the motor diaphragms on stokers and dampers and thus slow down operation.

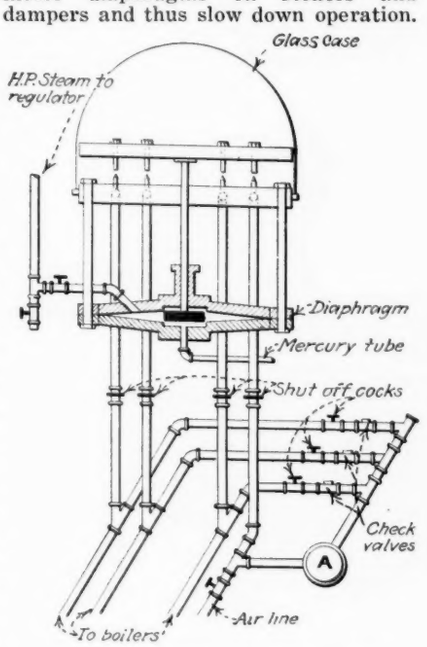


Fig. 2—Main pressure regulator

With a drop in steam pressure below normal the diaphragm moves upward opening the vent ports and speeding up operation. Owing to the sensitiveness of the regulator and the operating mechanism, intermediate positions of the damper and stoker regulators are obtained, so that changes are made gradually and the control system comes quickly to a balance instead of operating by frequent alternations from one extreme to the other.

As a final safeguard to check operation and prevent the boilers from blowing off, owing to a sudden drop in load, the reverse-acting diaphragm valve *A* has been provided. This valve has connection with the air system and also with an extra leak port.

As an illustration of its working suppose that the load drops off sharply. The steam pressure builds up, closing the vent ports on the air lines to each boiler. This action slows down the stokers and closes the dampers. If the latter should remain closed for any length of time, the temperature at the uptake will drop and through thermostatic action open the damper and increase the coal feed. At this point the extra vent port on the regulator closes, the valve having been set higher than the others, allowing the air pressure on the master valve to build up and through the manifold connection fill the lines to the boilers. This again slows the stoker speeds and closes the dampers until such time as the steam pressure reduces and by opening the leak port recloses the master valve. The boilers then go back on thermostatic control, and, when conditions are back to normal, on the main regulator.

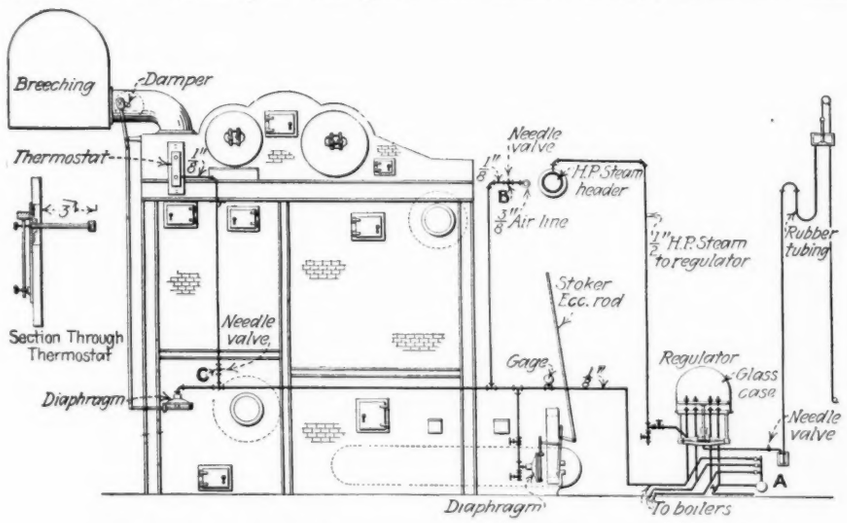


Fig. 1—Diagram of Lehnco pressure-thermostatic boiler control

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A.S.M.E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

IV—Rules for the Prevention of Direct Causes of Boiler Failures

(Continued)

Weakening of Structure Overheating

Excessive Combustion

C-172. Care shall be used that there is no weakening of the boiler structure due to fire cracks, abnormal crystallization of parts, and other defects because of an increase in combustion due to an increase in the rate of operation, increased stoker capacity, or change of fuel.

C-173. Care shall be used to prevent high furnace temperature that will cause a rapid melting of the furnace lining, destroying its value as an insulating protection of boiler parts and supports.

C-174. Spalling or wasting away of side walls, bridge walls, and arches as may be caused by the impingement of oil flames, contact of fuel bed, and other causes shall be guarded against as far as possible in order to maintain the safety of the structure. Gas pressure in the furnace shall be minimized as far as practicable, as pressure in the furnace forces hot gases out through the crevices in the setting and tends to destroy it.

Secondary Combustion and Flaming Through

C-175. Secondary combustion shall be prevented by admitting sufficient air at all times to facilitate the combustion of the fuel before the gas has traveled one-half the distance from the fire bed or burners to the exit of the setting. Care shall be exercised to prevent the leakage of air into the latter passes and thus burning the gases in the latter passes.

C-176. When fires are banked and the furnace temperature is reduced, make sure that enough air is carried through the furnace and boiler to prevent the accumulation of combustible gases within the setting.

C-177. When cutting out a boiler, stop the supply of fuel, burn out the fuel in the furnace, and adjust the dampers to cool off the setting and boiler as slowly as is consistent with operating conditions.

After the boiler ceases to require feed water and the non-return check valve, if any, on the steam outlet has closed, close the feedwater valves and the main steam stop valve. Where both one hand-operated stop valve and one combined stop and check valve are used, screw down the stem of the combined stop and check valve to hold the valve disk on the seat. Where two stop valves are used, open the drain between the stop valves and see that it is clear. When possible, dust off tubes before the fire has died out.

Localized and Uneven Heating

C-178. Ample time, as suggested in Par. C-13, shall be allowed for raising the steam pressure in order to prevent uneven heating of the setting and boiler. Uneven heating of the setting will result in cracking the lining and setting, particularly in new brickwork, thereby destroying its value as an insulator and support. Uneven heating of the boiler will cause unequal expansion, resulting in distorted tubes and opening of seams, especially where the circulation of water may be sluggish as in internally fired types of boilers.

C-179. Where refractories are provided to protect the surfaces in the steam space of a boiler that are not designed to withstand direct heating of the combustion chamber or action of excessively hot gases, such protective refractories shall be maintained in good condition.

C-180. Boilers should not be emptied until the brickwork cools, as uneven contraction may take place.

Damper Regulation

C-181. Where draft-control systems are used they shall not be considered as relieving the operator of responsibility. He shall be alert at all times to detect unusual conditions which may affect the safety of the structure. Such systems shall be maintained in good condition and be inspected periodically when the boiler is in service and at times of internal and external inspections, especially where failure of their operation may cause the dampers to close and cause a flareback.

C-182. Do not use any combustibles for igniting a coal fire in such a manner as to cause excessive smoke or possible flareback. Where pulverized coal, gas or oil is used as fuel, make sure that the outlet damper is open to create light draft before introducing and igniting fuel.

C-183. Where economizers not of the integral type are installed with inlet, outlet and bypass dampers, neither the inlet nor outlet dampers shall be closed when the bypass dampers are closed and the boiler is under fire or is being ventilated.

Insulation

C-184. Wherever insulating materials are used, they shall be inspected periodically and at times of internal inspections. They shall be maintained, as far as practicable, to the full value of their insulating properties and free from objectionable cracks or openings. Freedom of movement for expansion and contraction, where provided, shall be maintained as far as possible.

Feed-Water Supply

Control of Water Supply

C-185. Feed pumps and injectors shall be maintained in good condition. Feed-pump pressure regulators when used shall be maintained in good condition and shall be frequently tested under throttled discharge.

C-186. Sufficient head and quantity of water shall be maintained in feedwater tanks to prevent loss of suction of the feed pumps, and where hot water is fed to or allowed to splash in feed-water tanks, sufficient head and quantity of water shall be maintained in the tank to prevent entrainment of vapors.

C-187. All feed-water tanks shall be maintained free of oil and shall be cleaned as often as necessary to prevent an objectionable accumulation of sediment or other undesirable foreign matters.

C-188. Feed-water lines shall be kept free from objectionable vibration.

C-189. Leaks in the feed-water line shall be stopped as soon as possible.

C-190. Periodical inspections shall be made for possible scale and defective check valves in the feed line. For locating deposits or other obstructions in a feed pipe, it is recommended that a pressure gage be placed on the discharge chamber of the boiler-feed pumps or on the discharge pipe outside of the feed pump. When it becomes necessary to maintain an unreasonably high feed-water pressure, examine the feed-water lines for choking due to scale or other causes.

Control of Water Level

C-191. Special and constant care shall be exercised to maintain a proper water level in the boiler and to provide a continuous rather than an intermittent supply of water to the boiler. Never depend entirely upon automatic alarms or feed-water regulators, no matter how effective or valuable these devices may be.

C-192. When the operator is blowing down a boiler and cannot see the water glass, another operator should be placed to watch the water glass and signal the operator blowing down the boiler. Only one boiler at a time shall be blown down by any one operator. When blowing down the boiler, the operator shall give his entire attention to that duty and shall not perform any other duty.

*The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee. On account of the length of the rules *Power* is printing them in short installments, of which this is the sixth.

C-193. If feed-water regulators are used. see that they are maintained in good working condition, but do not place complete dependence on the regulators to maintain the proper level of water in the boiler.

C-194. Keep the communications and valves between the boiler and the water column and the water glass free and clear, and test by blowing down the water column and water glass, noting the promptness of the return of the water to the water column and glass and trying the gage cocks until sure of the water level.

C-195. All water columns and water glasses shall be tested by the water tender or operator directly responsible for the level of the water in the boiler, at the beginning of each shift and preferably before the relieved shift has gone off duty.

By "shift" is meant a person or group of persons who relieve a person or group of persons in rotation in standing watch or operating a steam generating plant for an allotted time. It is synonymous with "watch," "vigil," or "tour of duty."

C-196. Water glasses shall be tested after replacing. All water glasses on a boiler shall be tested when placed in service and when trouble is experienced with boiler compounds, foaming, priming, or other feed-water troubles that are apt to cause choking of the connections.

C-197. Water glasses and their connections shall be kept free from leaks and no connections allowing a flow of water or steam from the piping between the water column or water glass and the boiler shall be made, as such leaks or flow of water or steam will cause a false indication of the water level in the boiler.

C-198. Water glasses shall be kept well lighted and clean, and when in need of cleaning should be replaced with clean glasses. Attempts to clean glasses in place lead to possible cracking of the glass or choking from pieces of cloth or waste.

C-199. If difficulty is experienced in maintaining the proper water level in the boiler, the combustion shall be checked and the draft dampers and ashpit doors closed until the cause is discovered and corrected.

If the level of the water is not visible in the water glass, the gage cocks shall be tested to ascertain whether the level of the water is above or below the the water glass. If the level of the water is below the water glass, the supply of fuel and air shall be stopped and the dampers and ashpit doors shall be closed unless the progress of the declining water level has been carefully observed by a competent operator who is in touch with the entire situation as to the boiler feed-water supply and is positively certain that it is safer to continue steaming the boiler than to reduce the steaming rate.

If it has been found advisable not to reduce the steaming rate of the boiler, the cause of the trouble shall be determined and remedied immediately.

C-200. If it has been found advisable to stop the supply of fuel and air, the rate of feed-water supply shall not be changed, safety valves shall not be opened, steam outlet valves shall not be changed, nor shall any adjustment be made that will cause a sudden change in the stresses acting on the boiler. In the case of hand-fired boilers, do not disturb the fire except to cover it with green coal or wet ashes. Where stokers are used, stop the fuel feed and open the firedoors. After the fire is banked or out, the feed-water valves shall be closed. When the boiler is sufficiently cooled, the firedoors shall be closed and the boiler cut off the line. The cause of the trouble shall be determined and remedied before the boiler is again placed in service. Also, the boiler shall be examined for overheating.

Blowoff Equipment

C-201. Maintain the blowoff valves and cocks in good working condition and repair leaking blowoff valves as soon as practicable. See that they are in good working condition before putting a boiler in service and examine them periodically, when boiler is washed out and at times of internal inspection. Maintain in good condition the pipe and fittings between the blowoff valve and the boiler together with their insulation, and inspect them periodically, at times of internal inspection and particularly when the boiler is washed out. If the discharge end of the blowoff line is visible, watch it for the purpose of detecting leaky blowoff valves.

Blow-Down Regulation

C-202. In operating blowoff cocks and valves, they shall be opened and closed carefully and slowly; care shall be exercised to make sure that when the valves or cocks are closed, they are closed tightly.

C-203. The volume and number of blowdowns for a boiler should be governed by the condition of the water in the boiler and its effect on the quality of steam, and unless controlled by analyses made at intervals, the minimum blowdown shall be once in 24 hours.

C-204. Where the feed-water is high in solids, if the load is heavy or fluctuates and wet steam is delivered, the blowdowns must be regulated so that concentration of the suspended matter and dissolved solids is kept below the point at which priming or foaming begins or wet steam is delivered.

Where frequent blowing down does not overcome wet steam, the boiler carrying the highest concentrations should be dropped, cooled, emptied, and refilled with fresh water. If this does not correct the condition and more than one boiler is in operation, follow the same procedure with the other units, taking them down one at a time in order of the highest concentration.

C-205. The quantity of precipitates a steaming unit can hold without interfering with the quality and quantity of steam production, depends upon the type of unit in use, character of the precipitates formed, character of organic emulsions, character of the steam load, and nature and amount of the natural suspended matters and of the salts in solution; blowdown and water changes should be regulated from operating conditions by determining the amount of concentration practicable under the circumstances.

C-206. Where low soda alkalinities cause a boiler to be constantly sensitive to priming or foaming, it is recommended that oils contained in the exhaust steam in use for heating the feed water be first removed to the maximum extent by mechanical means rather than by attempting to control the priming and foaming through increasing the blowdowns.

C-207. If all oil cannot be removed by mechanical means and the boilers continue to deliver wet steam, it is recommended that the oil in use for cylinder lubrication be analyzed for fatty materials, and if present, that straight mineral oils be substituted.

Then, if wet steam is not eliminated, call upon a boiler expert for advice regarding circulation and steam liberation.

C-208. Where dry steam cannot be produced without excessive blowdowns and no change can be made in the boiler to relieve the difficulty, mechanical means should be provided for separating the water and solids from the steam before the water and steam are so finely divided as to make such separations uncertain or impossible.

C-209. Boilers should be blown down at determined intervals.

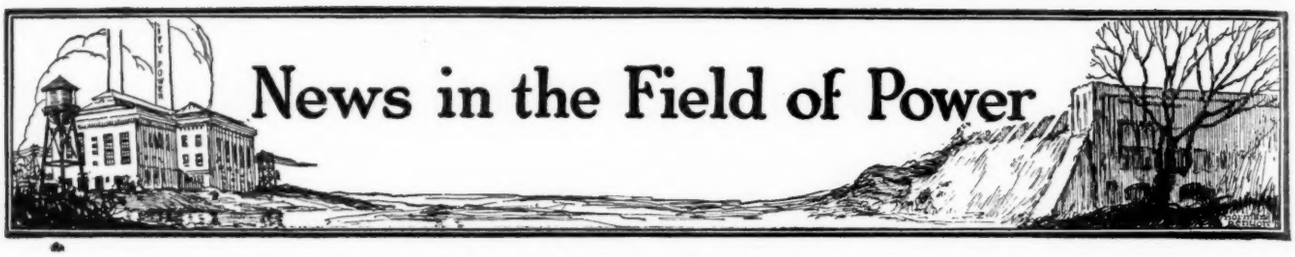
Fast Versus Slow Opening of Disconnecting Switches

The question has arisen as to the advisability of opening disconnect switches quickly or slowly. It is known that through mistakes, disconnects have been opened under a heavy load with serious trouble resulting. With a desire to avoid such trouble a few power companies have made a practice of partly opening a disconnect blade and quickly reclosing it again if the arc appeared to be of a tenacious nature.

On the other hand, advocates of quick opening, who for the moment disregard such safety precaution, argue that the arc due to a charging current or other permissible low current should be broken as quickly as possible to minimize the burning of blades and clips. Of 24 companies expressing a preference, 10 favored slow opening, while 14 favored quick opening, according to an investigation made by the Electrical Apparatus Committee of the National Electric Light Association.

It would seem that in consideration of all arguments offered, the decision as to a slow or quick opening would depend upon the particular function of the disconnecting switch and if it is used to supplement an oil circuit breaker. In such case the oil circuit breaker would be expected to be open and the precautionary method would be a wise one. In many installations disconnect switches are of single-pole type and are opened manually, one phase at a time. Precautionary methods in opening such type of switches slowly would also seem advisable.

The argument for quick opening would appear to hold greater favor in installations where disconnect switches are gang operated.



Argentina Increases Imports of Lubricants in 1925

Importations of lubricating oils and greases in Argentina from the United States and Europe increased considerably during the first four months of 1925 over the corresponding figures for last year. About 85 per cent of the imports comes from the United States, while most of the remainder is brought from Great Britain. A total of 39,525 bbl. (50 gallons each) was received during the first four months of 1925, compared with 31,333 bbl. during the corresponding period of 1924. In the period January to April, 1925, the United States supplied 33,543 bbl. and Great Britain 5,355. During these months of 1924 the United States furnished 30,020 bbl., and 938 came from Great Britain. The largest importation for a single month occurred in March of each year—10,881 in March, 1925, and 10,654 in the 1924 month.

Investigation of G. E. Co. Under Way

The investigation of the General Electric Co. is being continued actively by the Federal Trade Commission. The Commission has come to the conclusion that it may investigate whether or not the General Electric Co. monopolizes or controls, in restraint of trade, the production and distribution of electric power or the sale of electrical equipment and apparatus. Funds were appropriated to the Federal Trade Commission for use during the fiscal year which began July 1, with the proviso that no money could be expended for an investigation requested by a single house of Congress. This limitation, however, was not to apply when the investigation request deals "with alleged violations of the anti-trust acts."

In that connection the opinion has been expressed that a resolution by one house would have to make a positive allegation that the anti-trust statutes had been violated. The Commission, however, takes the view that the Senate itself does not have to make such an allegation, but that it is sufficient if the allegation is made on the floor of the Senate.

This means that the investigation will be carried forward actively from this time forward, perhaps more actively than would have been the case had there been no limitation on the appropriation bill. That proviso reduces the number of investigations which the commission can undertake and thereby makes available more money for those which are to be undertaken.

The commission is in doubt as to a portion of the work that it had begun before the expiration of the last fiscal year. That portion of its investigation has as its objective the establishment of whether the General Electric Co. resorted to propaganda intended to influence the people against public ownership. That part of the work was stopped on June 30, pending a report from the Attorney General as to whether it is precluded by the appropriation act proviso.

Bursting Valve Shuts Down 59th St. Station, N. Y. City

The bursting of a valve on the feedwater line in the Fifty-ninth Street station of the Interborough Rapid Transit Co., New York City, caused a 20-minute shutdown at about 7:30 p.m. on July 3.

The valve was an 8-in. gate located in a vertical riser at the point *A* indicated in the illustration, between the

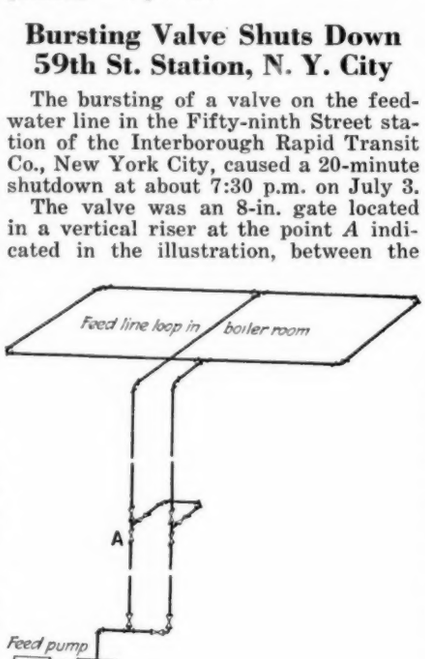


Diagram of piping showing location of valve

feed-pump discharge and the loop above the boilers. The body, which was of cast iron, fractured through the center parallel with the flange faces.

The pressure on the line is normally around 275 lb., and the temperature of the water at the time of the accident was approximately 220 deg. F. When the valve gave way, the hot water and steam completely covered the feed pumps and heater in addition to the other valves adjacent to the break and made it impossible for the operators to determine readily the seat of the trouble or to bypass that section of the line, with the result that before the necessary valves could be reached, the plant had to be shut down in order to hold a safe water level in the boilers.

What caused the valve to fracture has not been definitely determined, but it is thought that the expansion and contraction of the riser over a long period of service may have been a contributing factor. A section of the body has been cut out for the purpose of making micro-photographs and for analyses of the metal.

Copco No. 2 Dedicated with Formal Ceremonies

The opening of Copco No. 2 hydroelectric plant of the California Oregon Power Co., with dedicatory ceremonies, took place on July 5 in the presence of nearly two thousand customers, stockholders, business men and bankers.

The plant, which represents an investment of $4,000,000, is on the Klamath River in northern California a few miles south of the California-Oregon border.

Two 20,000-hp. turbines operating under a head of 140 ft., drive two 15,000-kw. vertical-type generators. A large proportion of the output of the plant will be sold to the Pacific Gas & Electric Co. under a long term contract.

Two Hetch Hetchy Penstocks Ruptured

Excessive pressure rise resulting from improper operation of a gate valve at the Moccasin power house of the City of San Francisco, caused the rupture of two penstocks on June 30. It is reported that an inexperienced operator failed to open the bypass value before opening a large gate valve at the power-house end of one of the penstocks. The water hammer set up by the sudden rush of water under a static head of 1,316 ft. through the short section of empty pipe between the gate valve and the waterwheel caused the failure of one of the penstocks, about 4,000 ft. from the power house. About fifteen minutes later a second break occurred in one of the other penstocks some distance from the power house.

With the penstock arrangement at this plant it may be possible for a series of pressure waves to build up that would gradually get sufficiently out of phase to cause an excessive surge in one of the penstocks, to account for this unusual happening. The Moccasin plant has four lap-welded steel penstocks leading down the slope to the power house. Each penstock branches into two pipes, containing gate valves, before entering the power house to the double overhung waterwheels. The two penstocks that broke were 66 in. in diameter at the point where the rupture occurred. These penstocks are over 5,000 ft. long and have a diameter at the top end of 66 in. and 54 in. at the power house.

The total damage estimated by the City Engineer's office is about $10,000. Besides the damage to the penstocks there was some damage done to the power house from mud and water washed down the hillside. Single sections of pipe will repair the damage to the penstocks, and it is expected that the plant will be ready for operation again within two weeks.

Shoals Temporary Power Goes to Alabama Power Co.

Revenue in excess of $500,000 will accrue to the Federal Treasury as the result of an informal agreement that will permit the distribution of the power developed at Muscle Shoals during the testing period. The Alabama Power Co., on its own account and on behalf of the other power companies forming a part of the Southern interconnected system, has agreed to pay two mills per kilowatt-hour for this power, with the understanding that the supply of power may be shut off without warning and with no assurance as to the amount of power that is to be made available at any time. The arrangement gives the government the advantage of testing out the equipment under full-load conditions. The necessary transformers are furnished by the Alabama company.

While the uncertainties of this plan will not justify the construction of additional transmission lines, it will afford material help in assisting the power companies to tide over a season of unusually low water. For several weeks, the War Department has been advised, it has been necessary for steam plants in Alabama to make up a power shortage in Georgia.

Boiler Feed Water Survey To Be Made

According to S. T. Powell, chairman of the advisory committee, preliminary organization work on the feed-water survey recently initiated by the American Water Works Association is now well under way. The work will be carried on with the active co-operation of the N.E.L.A., the A.S.M.E. and the American Railway Engineers Association, each of these organizations being well represented on the committees.

There are eight of these subcommittees with subjects and chairmen as follows: Subcommittee No. 1, "Sedimentation With and Without Chemicals, Pressure and Gravity Filters and Deconcentrators, Continous Blowdown Apparatus," a study of these methods applicable to steam station and railroad practice, chairman, R. C. Bardwell, Supt. Water Service, C. & O. R.R., Richmond, Va.; Subcommittee No. 2, "Water Softened by Chemicals," external treatment, chairman, C. R. Knowles, Supt. Water Service, Illinois Central R.R., Chicago, Ill.; Subcommittee No. 3, "Zeolite Softeners, Internal Treatment, Priming and Foaming, Electrolytic Scale Prevention," chairman, Prof. Alfred H. White, University of Michigan, Ann Arbor, Mich.; Subcommittee No. 4, "Surface Condensers, Evaporators and Deaerators," chairman, Prof. Alfred H. White, University of Michigan, Ann Arbor, Mich.; Subcommittee No. 5, "Corrosion of Boilers and the Effect of Treated Water in Accelerating or Relieving These Troubles," chairman, Prof. H. Jermaine Creighton, Swarthmore College, Swarthmore, Pa.; Subcommittee No. 6, "Embrittlement of Metals," chairman, Prof. A. G. Christie, Johns Hopkins University, Baltimore, Md.; Subcommittee No. 7, "Municipal Water Supply in Relation to Boiler Use," chairman, V. Bernard Siems, Water Engineer, Baltimore, Md.; Subcommittee No. 8, "Bibliography," chairman, P. W. Swain, *Power*.

It is generally admitted that no subject in the power-plant field is in greater need of a comprehensive survey than that of boiler-feed water. Much remains to be found out. Even existing information is scattered and hard to collect. It is hoped, however, that with nearly one hundred representative engineers on the various committees, some semblance of order will be brought out of the present chaos. The committee members recognize that the task is a big one and that it may require years to cover the present program.

Work Starts Next Week on Sesquicentennial Buildings

The news of the appointment of L. R. Meisenhelter as director of exhibits of the Sesquicentennial International Exposition at Philadelphia in 1926, gives definite confirmation to the former announcements that there are to be exhibits of machinery, manufactures, transportation and mines and metallurgy. Mr. Meisenhelter belongs to the Engineering Society of Pennsylvania and the A.S.M.E. and has had considerable experience in arranging exhibits in expositions at San Francisco, Atlantic City and New York City.

L. R. Meisenhelter

Plans for the exposition halls are rapidly maturing, and it is announced that ground will be broken for the first building on the site selected on July 20. Bills providing for a sewage-disposal plant and for a bridge have been passed by the Public Works Committee of the Philadelphia City Council.

Various states and many societies and clubs have signified their intention to participate in the Sesquicentennial. Although getting a late start and having many serious obstacles to overcome, the exposition seems to be now definitely under way. It is to be hoped that the quarters provided for exhibitions of new developments in the power-plant field will be adequate and the industry will have a showing worthy of such an anniversary as the Sesquicentennial represents.

St. Lawrence River Power Possibilities To Be Studied

The firm of Blackwell & Buck, of New York, has been retained in a consulting capacity by the American members of the Joint Engineering Board for the St. Lawrence. The firm will make certain studies in connection with the hydro - electric possibilities of the stream. Representatives of the firm are now on a trip up the river with Col. William Kelly and Col. G. B. Pillsbury, members of the Board.

New Steam Plant for Salem, Mass.

A tidewater steam generating plant of about half a million kilowatts ultimate rating is now being designed by Charles H. Tenney & Co. of Boston, for construction on a site at Salem, Mass., which has been under partial development for some time as a coal-storage and handling terminal for the Tenney properties north of Boston. The initial installation will have a rating of about 100,000 kw.

The capacity of the present coal-storage plant at Salem probably will be increased from 100,000 tons to 300,000 tons as the development proceeds and the handling plant capacity will be raised from 2,000 tons to 4,000 tons per day. The existing steam plant at Salem is interconnected with the Boston Edison stations, and the construction of the new Salem plant will provide a station of major size north of Boston, comparable in rating with the later installations south of the city.

Purdue Will Investigate Indiana Coal Qualities

A thorough series of investigations and experiments with Indiana coal has been started by the engineering experiment station of Purdue University, the results of which are expected to prove of great value to users of Indiana coal. The work is being carried on under the direction of Dr. A. A. Potter, dean of engineering and director of the station, with the following men actively engaged: Prof. A. W. Cole, Prof. J. L. Bray, W. E. Gray and J. P. Walstead.

Particular attention is being given to the steaming qualities of the coal. Boiler tests are being made at various industries using a variety of firing methods including mechanical stoking, and all sorts of furnace designs. Representative samples of Indiana coal are being taken from Indiana concerns and are being analyzed chemically. Professor Bray, a mining specialist with over ten years of experience with North and South American coal products, is making a critical study of mine methods used with a view of giving to mine owners the benefit of his experience.

The investigation is entirely a fact-finding process and no opinions will enter into the investigations. Coal from practically every mining district in the state is being used and it is the aim of those in charge of the work to set forth what can be expected from Indiana coal for steam generation. It is expected that the results of the work will be published as a bulletin of the engineering experiment station.

Niagara River Discharge Measurements Being Made

Discharge measurements are being made in the Niagara River under the direction of the Corps of Engineers. These data are for use in connection with the studies being made of the lake levels and the other problems where conditions in the Niagara River are involved. The measurements will continue throughout the summer and will be compared with similar data secured ten years ago.

Spaulding-Drum Power Houses To Get More Water

Work on raising the dam of Lake Fordyce, Calif., is under way. The dam, originally built in 1873 to impound water for hydraulic mining, has been raised three times and plans now being carried out by the Pacific Gas & Electric Co. will give the total height of 116 ft. and double the lake's storage capacity. The additional water will be used to increase the generating capacity of the Spaulding-Drum power houses.

Consumers' Stocks of Soft Coal Decrease

An inventory of the stocks of bituminous coal in the hands of consumers, conducted by the Geological Survey, reveals that the total quantity in storage on June 1, 1925, was 38,000,000 net tons, against 44,000,000 tons on March 1, 1925, and 51,000,000 tons on June 1, 1924. The trend of stocks has been steadily downward since the early part of 1924, and the heavy reserves built up by consumers in late 1923 have been reduced to more normal proportions; in fact, the present supply is slightly less than that in the summer of 1921.

Measured in tons, there was a reduction in stocks of 19 per cent during the period Sept. 1, 1924, to June 1, 1925, of which 14 per cent occurred during the last three months. At the rate of consumption prevailing from March 1 to June 1, the stocks on June 1 would last 32 days if evenly divided, a decrease of 29 per cent compared with the 45 days' supply on hand Sept. 1, 1924.

In addition to the quantity in the storage piles of consumers and dealers, it is estimated that the following quantities were in transit on June 1: On the commercial docks of Lakes Superior and Michigan, 3,800,000 tons; in storage at the mines or at intermediate points, 150,000 tons.

New Holding Company for Niagara Power

Buffalo, Niagara & Eastern Power Corp. is the new public-utility holding company, which has recently been formed to acquire the controlling interest of the Niagara Falls Power Co., Niagara Lockport & Ontario Power Co., Buffalo General Electric Co. and the Tonawanda Power Company.

The zone served by Niagara power is about 300 miles from east to west and about 100 miles from north to south, or from Erie to Syracuse and from the Niagara frontier to Bradford, Pa. At Niagara the electrochemical industry requiries a constant and reliable supply of power which results in a high load factor. Probably nowhere in the country are the power-generating facilities used to so full an extent of their capacities as they are in this region. The demand all through the territory served by these companies is so great that the present holding company was formed to distribute and render a more constant and reliable service as well as to effect many operating economies.

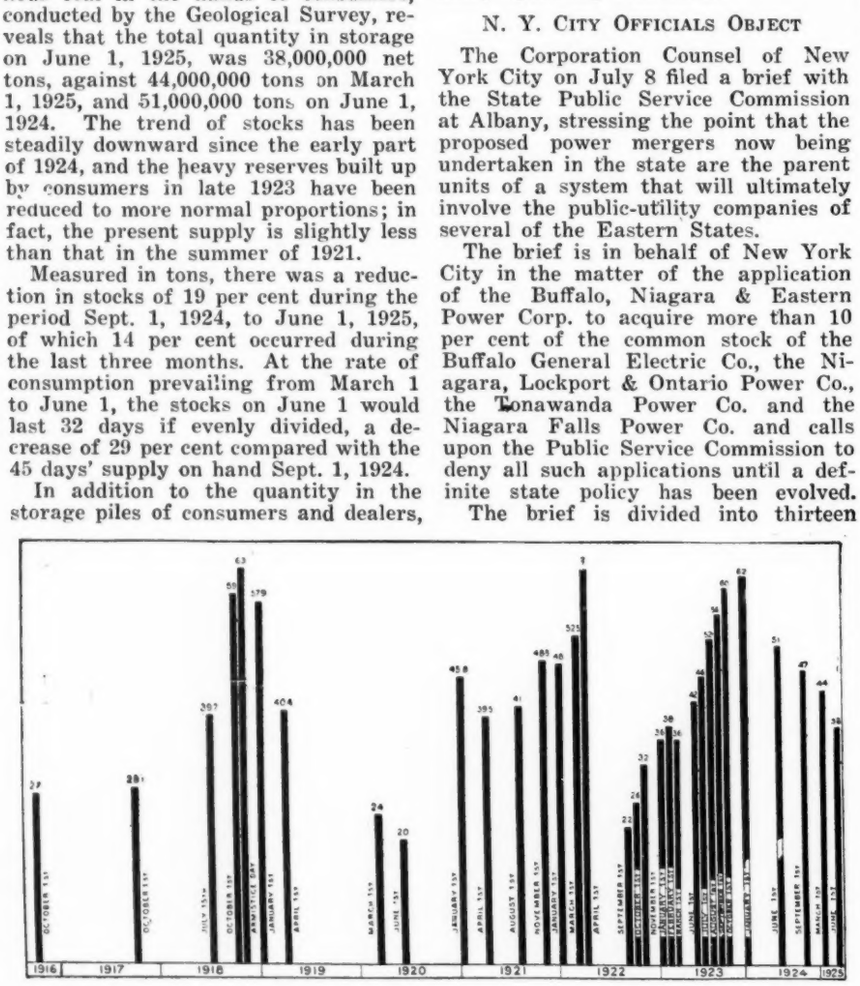
N. Y. City Officials Object

The Corporation Counsel of New York City on July 8 filed a brief with the State Public Service Commission at Albany, stressing the point that the proposed power mergers now being undertaken in the state are the parent units of a system that will ultimately involve the public-utility companies of several of the Eastern States.

The brief is in behalf of New York City in the matter of the application of the Buffalo, Niagara & Eastern Power Corp. to acquire more than 10 per cent of the common stock of the Buffalo General Electric Co., the Niagara, Lockport & Ontario Power Co., the Tonawanda Power Co. and the Niagara Falls Power Co. and calls upon the Public Service Commission to deny all such applications until a definite state policy has been evolved.

The brief is divided into thirteen points of argument and is signed by George P. Nicholson, Corporation Counsel of the City of New York, M. Maldwin Fertig and Joseph P. Morrissey, of Counsel. The points are briefly: This application may set a precedent which would affect the citizens of New York City should the city companies be also merged, as is rumored; it is a violation of Sec. 7, Chap. 323, of the Clayton Act (the anti-trust act), and company may contend, should rate questions arise, that it is an interstate affair; purchase of stock would do an injustice to the present owners and future investors; this purchase of stock contemplates no benefit to the public and more than doubles the stock; the Commission during the short time in which the application has been pending has been unable to make a thorough investigation of the value of the plants; this sale would completely stifle competition; the stage is being set for a big public-utility clean-up; public officials and persons are quoted as being opposed to granting of the petition; methods of Adirondack Power & Light Corp. are attacked and a plea for state development of St. Lawrence River power is set up; action of Maine in refusing to permit electricity generated there to be transmitted into other states for sale is quoted; an extract from a speech by Governor Pinchot of Pennsylvania on June 30, in which he warns the people to watch the electrical groups was cited; it was not only admitted, but the information was volunteered at the hearings, that some of the stock involved in this purchase was manipulated in a manner that would make possible an avoidance of income taxes.

The United States exported 75,682 lb. of leather belting, valued at $115,313, during May, 1925. Of this quantity Canada purchased 14,162 lb.. China 11,490 lb., South America 11,150 lb., Mexico 6,144 lb., Cuba 5,341 lb., and British India 4,984 lb. The exportation during the first five months of 1925 of 505,719 lb. valued at $740,023, was an increase of approximately 70,000 lb. in quantity and $90,653 in value over the exports during the corresponding period of 1924, according to government reports.



Total Commercial Stocks of Bituminous Coal Oct. 1, 1916—June 1, 1925

Personal Mention

J. Ledlie Hees, of Gloversville, N. Y., has resigned as president of the Adirondack Power & Light Corp.

A. Stuart Pratt and C. F. W. Wetterer have been appointed general executives of the operating division of Stone & Webster, 147 Milk St., Boston, Mass. They have full charge of that division, including operating division departments in the Boston office.

G. C. Riddell, chief of the Minerals Division of the Bureau of Foreign and Domestic Commerce, has tendered his resignation to acting Director O. P. Hopkins, effective July 1. Mr. Riddell will settle in New York as consulting engineer for the Alaska Pacific Coal Company.

Harold Goodwin, Jr., has severed his connection with Sanderson & Porter, engineers, New York City, to become associated with the Columbia Gas & Electric Co., also of New York City.

Walter H. Fulweiler, chemical engineer, United Gas Improvement Co., Philadelphia, Pa., was elected president of the American Society for Testing Materials at its annual convention at Atlantic City recently.

Thomas E. Purcell, formerly mechanical engineer with Dwight P. Robinson, Inc., consulting engineers and constructors, New York, is now general superintendent of power stations for the Duquesne Light Co., Pittsburgh, Pennsylvania.

Business Notes

The Andrews-Bradshaw Co., 530 Fourth Ave., Pittsburgh, Pa., sales manager for the Tracyfier, announces the appointment of J. Lucien Jones as advertising manager of the company. Mr. Jones was formerly connected with the Moss Chase Co., Buffalo, N. Y.

The Marion Machine, Foundry & Supply Co., Marion, Ind., announces that John S. S. Fulton, Baltimore, Md., assumed charge on June 1 of the stoker department of the company; George L. Sharp, for six years general comptroller of the company, has been promoted to manager of the Scottdale plant.

D. H. Braymer Equipment Co., Omaha, Neb., is the name of a new firm which will specialize in consulting and sales work associated with power applications in industrial plants, large buildings and power plants. Mr. Braymer, who was formerly editorial director of *Industrial Engineer*, Chicago, will have associated with him Marvin Philips. The firm will also act as representative of several manufacturers of related power equipment in the States of Nebraska and Iowa and the cities of St. Joseph and Kansas City, Mo.

A Correction—In the July 7 issue it was erronously stated that the Engineer Co., 17 Battery Place, New York City, was opening a new branch in Newark. It should have been said that Frank Beers, formerly with the Engineer Co., was opening his own office at 760 Broad St., Newark, N. J., for the handling of power plant specialties.

Trade Catalogs

Water Softener—Graver Corp., East Chicago, Ind. Bulletin 509 just issued, the "Graver Zeolite Water Softener," describes this equipment and shows pictures of typical installations.

Stokers—Cokal Stoker Corp., 341 East Ohio St., Chicago, Ill. "Does 25 per cent Interest You?" is a small booklet showing the advantages of motor-operated stokers in the small industrial plant. It may be secured free from the company.

Valves, Motor Operated—Chas. Cory & Sons, Inc., 183 Varick St., New York City. Bulletin No. 103-29-B "Cory-Recony Standardized Unit Control for Motor Operation of Valves," describes the types of motor operated valves manufactured by this company as well as the indicating system. The bulletin is illustrated with good photos of the equipment.

Engines—The Prosser Co., Cleveland, Ohio. Bulletin 104 contains, beside descriptions and illustrations of this engine, the tests made by Prof. E. F. Miller, Massachusetts Institute of Technology, Lockwood, Greene & Co., architects and engineers, Boston, Mass., and Prof. L. V. Ludy, of Purdue University, LaFayette, Ind.

Furnace Arches—The Brady Conveyors Corp., 20 West Jackson Blvd., Chicago, Ill. Bulletin No. 20, just issued, describes the standard Brady flat suspended combustion and ignition arch, bringing out the details of the radial construction at the rear and the curtain wall and supports, the arch rack and extension and the drop or ignition arch with illustrations to show the adaptability of the flat arch to all types of boilers and stokers.

Coming Conventions

American Chemical Society. Charles L. Parsons, 1709 G St., N. W. Washington. Meeting at Los Angeles, Aug. 3-8.

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Gas Products Association, Charles T. Allen, 140 South Dearborn St., Chicago, Ill. Eleventh annual convention at "The Grand," Mackinac Island, Mich., July 21-23.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Michigan Association** at Muskegon, July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Universal Craftsmen Council of Engineers. Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Twenty-third international convention in the Armory, at Akron, Ohio, August 3-8.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	July 6, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	4.10@ 4.35
Clearfield	Boston	1.60@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.00@ 1.25
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.40
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.60

FUEL OIL

New York—July 8, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis — July 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.5c. per gal.

Pittsburgh — July 3, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—July 1, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia — July 3, 28@30 deg., $2.205@$2.268 per bbl.; 18@22 deg., $1.932@$1.985; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—July 7, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4⅝c. per gal. light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati — July 1, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

New Plant Construction

Ark., Batesville—City, E. H. Glenn, Supt., is in the market for a new 300 hp. Diesel engine for electric light plant.

Calif., Aptos—Monroe-Lyon & Miller, c/o B. Schreyer, 105 Montgomery St., San Francisco, Archt., is having preliminary plans prepared for the construction of a hotel here. Estimated cost $1,000,000.

Calif., La Mesa—La Mesa Lemon Grove and Spring Valley Irrigation Dist., is having plans prepared for irrigation project including the construction of several small pumping plants and balancing reservoirs $10,000 and $30,000 respectively. T. H. King, Fletcher Bldg., San Diego, is engineer.

Calif., Los Angeles—W. H. Anderson, Title Insurance Bldg., awarded contract for the construction of a 17 story hotel on S. W. cor. 1st and Hill Sts. to Kinne & Westerhouse, 6533 Hollywood Blvd. Estimated cost $700,000. Steam heating, ventilating and refrigerating systems will be installed.

Calif., Los Angeles—F. N. Dlouhy, 1209 Pershing Square Bldg., Archt., is preparing preliminary plans for the construction of a 13 story hotel including steam heating, refrigeration and sprinkler systems at Boylson, Beaudry and 5th Sts. Estimated cost $800,000. Owners' name withheld.

Calif., North Sacramento—City is having plans prepared for an outfall sewer to connect with Sacramento system involving the construction of pumping plant. J. N. Bidwell, 1501 Del Paso Blvd., is engineer.

Calif., San Francisco—Hartford Fire Insurance Co., 438 California St., plans the construction of a 4 story office building on California St. near Grant Ave. Estimated cost $600,000. Architect not selected.

Conn., Waterbury—Connecticut Co., West Main St., awarded contract for the construction of a 2 story railway service office on West Main St., to Clark Construction Co., 168 Grand St., boiler house to Sullivan & McKeon, 937 Dixwell Ave., New Haven. Total estimated cost $150,000.

Ga., Atlanta—Atlantic Ice & Fuel Corporation, W. B. Baker, Pres., Washington St. Viaduct, is having plans prepared for the construction of a 1,000 ton daily capacity ice plant and a 15,000 ton storage plant. Estimated cost $300,000. Private plans.

Ga., Valdosta—D. C. Ashley Estate, is having preliminary plans prepared for the construction of a 10 story hotel. Estimated cost $500,000. W. T. Lane, Jr., 1422 Peachtree St., Atlanta, will finance project.

Ind., Indianapolis—Chamber of Commerce, plans the construction of a 10 story office building on Meridian St. Estimated cost $1,500,000. R. F. Daggett, Continental Bank Bldg., is architect.

Ind., Indianapolis—Methodist Hospital, 1604 North Capitol Bldg., plans the construction of a hospital on North Capitol Ave. Estimated cost $700,000. Vonnegut, Bohn & Muller, Indiana Trust Bldg., are architects.

Ind., Muncie—Ball Bros., plans the construction of a 5 story hospital. Estimated cost $1,000,000. C. Kibele, 118 East Adams St., is architect.

Ind., Rockville—Indiana State Sanitorium, plans the construction of a power plant. Estimated cost $50,000. C. Brossman, Merchants Bank Bldg., Indianapolis, is engineer.

Ia., Burlington—Citizens Water Co., F. Lawlor, Supt., will receive bids until July 21st for the construction of a pump house. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., are consulting engineers.

Mass., Boston—Carlin & Cherney, 115 Brighton St., is having preliminary plans prepared for the construction of an apartment at 250 Beacon St. Estimated cost $1,000,000. G. N. Jacob, 4 Park St., is architect.

Mass., Lynn—Commission on Ways and Drainage, will receive bids until August 18th for two 10,500 and two 21,000 g.p.m. sewage pumping units, pumping equipment, etc. Morris Knowles, Inc., Pittsburgh, Pa., is engineer.

Mo., Charleston—City is having plans prepared for sewer extensions and sewage pumping station. F. L. Wilcox, Chemical Bldg., St. Louis, is engineer.

Mo., Kansas City—City Bank, 1801 Grand Ave., is having plans prepared for the construction of a 6 story bank and office building at 18th and Grand Sts. Estimated cost $600,000. Holden, Ferris & Barnes, 1016 Baltimore St., are architects.

Mo., Kansas City—City Ice Co., plans the construction of an ice and storage plant. Private plans.

Mo., Kansas City—H. E. Fisher, c/o Fisher Building Co., Commerce Bldg., is having plans prepared for the construction of an 11 story hotel at 1010 Locust St. Estimated cost $850,000. W. J. Koch, 801 Mutual Bldg., is architect.

Mo., Malden—City plans an election to vote $53,000 bonds for improvements to waterworks and electric light plant. F. L. Wilcox, Chemical Bldg., St. Louis, is engineer.

Mo., St. Louis—J. T. Craven, Century Bldg., awarded contract for the construction of a 7 story apartment hotel at 4535 Lindell Blvd. to Boaz-Kiel Construction Co., Choteau Trust Bldg. Estimated cost $500,000.

Mo., St. Louis—C. T. Davis, 2142 Railway Exchange Bldg., is in the market for 25 and 50 hp. Fairbanks-Morse type oil engines and generators, etc.

Mo., St. Louis—Holbrook Blackwelder Real Estate Trust Co., 1010 Olive St., is having preliminary plans prepared for the construction of a 20 story office building at Olive and 10th Sts. Estimated cost $1,500,000. P. J. Bradshaw, International Life Bldg., is architect.

Mo., St. Louis—St. Anthony's Hospital, Grand Blvd. and Chippewa St., is having preliminary plans prepared for the construction of a 3 story hospital addition. Estimated cost $500,000.

N. J., Trenton—State Board of Education awarded general contract for alterations and additions to power plant including transforming of boiler plant from oil to coal burning to T. M. Day, Hunt Bldg. Total estimated cost $25,640.

N. Y., Troy—Community Hotel Corporation, awarded general contract for the construction of an 8 story hotel on Broadway to E. F. Carlson Co., 244 Main St., Springfield, Mass. Estimated cost $1,000,000.

O., Akron—St. Thomas Hospital, plans the construction of a 3 story hospital. Estimated cost $500,000. F. C. Warner and W. R. McCornack, Bulkley Bldg., Cleveland, are architects.

O., Cleveland—City is having plans prepared for the construction of a 54 x 100 ft. pump house, also intake, tunnel, etc. Estimated cost $250,000. H. Kregelius, City Hall, is architect.

O., Cleveland—City, H. Wright, Dir. of Public Utilities, City Hall, will receive bids until July 17th for the construction of a transformer house on Windsor Ave. Estimated cost $40,000. H. Kregelius, 604 City Hall, is architect. C. G. Beckwith is engineer.

O., Cleveland—Cleveland Electric Illuminating Co., Illuminating Bldg., c/o J. Wolf, engineer of construction, will receive bids until July 18th for the superstructure of an electric generating station on Avon Beach. Total estimated cost $10,000,000. McClellan & Junkersfeld, 68 Trinity Place, New York, are engineers.

O., Columbus—Pittsburgh Coal Co., 12 North Third St., F. S. Knox, Mine Supt., is in the market for one 500 hp. boiler, one 50 hp. motor for mine No. 76 at Thomas near Pomeroy, to replace fire loss.

Okla., Duncan—City plans an election July 18th to vote $110,000 bonds for new wells, pumping equipment, mains, 600 hp. air compressor, etc. Z. Z. Rogers, is engineer.

Okla., Enid—Enid Power Co., is having preliminary plans prepared for the construction of a new 2,000 hp. Diesel power plant. Estimated cost $250,000. J. Clover, 402 West Broadway, is engineer.

Okla., Guthrie—City, W. J. Mathis, Comr., is in the market for 500 and 750 g.p.m. centrifugal pumps against a 240 ft. head.

Okla., Lawton—Southwestern Light & Power Co., Continental Bldg., Oklahoma City, is having preliminary plans prepared for the construction of a new 5,000 kw. steam turbine unit here. Estimated cost $250,000. E. R. Erusberger, Continental Bldg., Oklahoma City, is engineer.

Okla., Marland—City, D. C. Fields, Clk., will receive bids until July 16th for the construction of a new waterworks system including a 25 g.p.m. triplex pump, 10 hp. oil engine, 50,000 gal. tank on tower, etc. Estimated cost $20,000. P. P. Dutton, Ponca City, is engineer.

Okla., Oklahoma City—City, J. H. Patterson, Comr., is in the market for a 2,000 g.p.m. motor driven centrifugal pump and motor for waterworks system.

Okla., Walters—City plans an election July 23rd to vote $25,000 bonds for the construction of a dam across the Cache Creek, also spillway, pump, etc. A. F. Thompson is engineer.

Pa., Pittsburgh—Manoa Realty Co., c/o H. L. Stevens & Co., 30 North Michigan Ave., Chicago, Ill., Archts., will build a 9 story addition to apartment on Bellefield Ave. Estimated cost $500,000. Owner will award sub-contracts.

Pa., Pittsburgh—J. M. Donn, 1219 Connecticut Ave., Washington, D. C., is having plans prepared for the construction of a 9 story apartment on Ellsworth Ave. here. Estimated cost $1,000,000. Private plans.

Tenn., Knoxville—City is having plans prepared for the construction of a new pumping station, a 15,000,000 gal. filter plant and elevated storage reservoir. Estimated cost $1,500,000. Alvord, Burdick & House, Hartford Bldg., Chicago, Ill., are engineers.

Tex., Abilene—City plans an election soon to vote $250,000 bonds for the construction of a waterworks system including pumping equipment, wells, mains, etc. C. E. Coombe, is Mayor.

Tex., Beaumont—East Texas Electric Co., c/o E. S. Fitz, Supt., is having plans prepared and will soon receive bids for the construction of a 120,000 kw. power plant. Estimated cost $5,000,000. Stone & Webster Engineering Corp., 147 Milk St., Boston, Mass., are engineers.

Tex., Houston—Neils Esperson Estate, c/o Mrs. N. Esperson, 16112 National Bank Bldg., will receive bids about August 1st for the construction of a 26 story office building including 8 passenger and 2 freight elevators at Travis St. and Rush Ave. Estimated cost $2,000,000 J. Eberson, 212 East Superior St., Chicago, Ill., is architect.

Tex., Lubbock—City voted $150,000 bonds for improvements to waterworks system including pumping equipment, mains, etc. J. R. Germany is Secretary.

Tex., Port Arthur—Kansas City Southern Railway, 25 Broad St., New York, does not plan the construction of power plant, etc., here. This corrects report in June 2nd issue.

Tex., Temple—Temple Ice & Refrigerating Co., 401-409 South 2nd St., plans the construction of a 40 ton ice plant at West Avenue A. and 5th St. Estimated cost $150,000. Ophuls & Hill, 112 West 42nd St., New York, are engineers.

Wis., Beloit—Beloit Water Gas & Electric Co., Public Service Bldg., awarded contract for the construction of a 2 story addition to boiler house to Adams Construction Co., 217 Clarkson St., Chicago, Ill. Estimated cost $50,000.

N. B., Fredericton—Electric Power Comn., will receive bids until July 29 for the construction of a main dam across the Saint Johns River, also intake, forebay, tunnel and power house. Bids for machinery and equipment for power plant will be received later.

Ont., South Porcupine—Township of Tisdale, F. C. Evans, Clk., will soon receive bids for one 600 g.p.m. electrical centrifugal pump and one 1,000 g.p.m. gasoline driven centrifugal pump. Sutcliffe & Co., New Leskeard, are engineers.

Ont., Toronto—University of Toronto Athletic Assn., plans the construction of an artificial ice rink. Estimated cost $150,000. Harkners, Loudon and Hertzberg, are engineers. Darling & Pearson, 2 Leader St., are architects. Complete artificial ice plant will be required.

Ont., Toronto—Yolles & Rotenberg, 85 Richmond St. W., plans the construction of a 12 story office building including a vacuum steam heating system and electric elevators at Bay and Temperance Sts. Estimated cost $500,000. Chapman & Oxley, Harbor Bldg., are architects.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Price changes during the past month occurred chiefly in hose, leather belting and lacing, armored cable and rubber covered copper wire. In the case of hose and wire there was an advance. The drop in linseed oil is seasonal in anticipation of adjustments for the new flax crop. A decline is also shown in rivets while the refractories show some advances.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		65c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply....$0.36	4 ply....$0.44	

Steam—Discounts from List

First grade....40%	Second grade....40-5%	Third grade..40-10%	

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50-5%	Second grade	50-10-5%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40%
Heavy	30-10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@$2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15@22	19.00	14.00
Colored	10.00@15.50	18.00	9.50

WIPING CLOTHS—Prices per pound in lots of about 600 lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	$0.11*	$0.11*
New York	17½	
Cleveland (*per thousand*)	36.00	45.00

*White, at washery.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.01	$1.10	$.99

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	15.75	15.00	17.25	16.50
White	15.75	15.00	15.75	15.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than ½-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$5.00*	Chicago	$3.50	Pittsburgh	$2.40@2.50

Boiler rivets, same sizes:

New York	$5.20*	Chicago	$3.70	Pittsburgh	$2.75@2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	19.00@20.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	65.00	50.00
(35% tin)	28.00	20.50	28.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$4.00	$3.80
Flats, squares and hexagons, per 100 lb. base	4.65	4.50	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19 20
1½	.....	$38.00	17.92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3¼	.....	49 50	30 67
3½	31 50	52 75	33 33
4	38.03	67 00	40 11

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$33.00 (net)	$ 50.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	60%	30%
1,000 to 5,000 ft.	60–10%	35%
5,000 ft. and over	60–10–5%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50 13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508 50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$21.00
No. 16 cotton reinforced heavy	24.00
No. 18 cotton reinforced light	17.00
No. 16 cotton reinforced light	20.25
No. 18 cotton Canvasite cord	15 25
No. 16 cotton Canvasite cord	17.50
No. 16 super service cord or similar	75.00
No. 14 super service cord or similar	115 00

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1 25	1.35	24
				500	2 00	2.15	12
				750	3.50	3.70	8
				1.000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.85	$9.18	$10 80	$17.00
12	9.33	11.85	13 60	22.50
10	12.35	15 50	17 20	29.00
8	17.30	20.40	22 40	39.05
6	.....	.....	30.10	.....
4	.....	.....	44 10	.....
2	.....	.....	63 50	.....
1	.....	.....	83 70	.....
0	.....	.....	110 68	.....
00	.....	.....	130 90	.....
000	.....	.....	156 50	.....
0000	.....	.....	186 82	.....

SOCKETS, BRASS SHELL—

¼ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	⅛ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.35*	$0.39	$0.36	$0.39*
		.30*			.34*
		.28*			.32*

Less 1-5th standard package	30%
1-5th to standard package	35%
Standard package	40%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%